Final Report of the Committee to Recommend Alternatives to the Uranium Processing Facility Plan in Meeting the Nation's Enriched Uranium Strategy

Date: 15 April 2014

Oak Ridge, Tennessee

Thom Mason, Chair

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S. A. Hawks April 18, 2014

NPO Y-12 Site Office Classification Officer Date

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Abbreviated Terms

ANS	American Nuclear Society
ANSI	American National Standards Institute
CD	Critical Decision
COO	Chief Operating Officer
CS	Chemical Safety
CTA	Central Technical Authority
DBA	design basis accident
DER	direct electrolytic reduction
DNFSB	US Defense Nuclear Facility Safety Board
DOD	US Department of Defense
DOE	US Department of Energy
DSA	Documented Safety Analysis
ER	electro-refining
EU	enriched uranium
EUM	Enriched Uranium Mission
FPD	Federal Project Director
FP	Fire Protection
FRR	Facility Risk Review
FRR II	Facility Risk Reduction, Phase II
FSS	fire suppression system
FY	fiscal year
HEPA	high-efficiency particulate air
HEU	highly enriched uranium
HEUMF	Highly Enriched Uranium Materials Facility
HSS	Health, Safety, and Security
HVAC	heating, ventilation, and air conditioning
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IS	Industrial Safety
ITM	inspection, testing, and maintenance
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LS	limited state
M&O	management and operating
MAA	material access area
MAR	Material at Risk
MPFL	maximum possible fire loss
NA-10	DOE/NNSA Defense Programs

NA-APM	DOE/NNSA Acquisition and Project Management
NCS	Nuclear Criticality Safety
NFPA	National Fire Protection Association
NMC&A	Nuclear Materials Control and Accountability
NNSA	National Nuclear Security Administration
NPH	Natural Phenomena Hazard
NPO	NNSA Production Office
NQA1	ASME Quality Assurance Requirements for Nuclear Facilities Applications
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PC-2, PC-3	Performance Category -2, -3
PEX	product extraction
PIDAS	Perimeter Intrusion Detection and Assessment System
PRD	program requirements document
R2A2s	Roles, Responsibilities, Accountabilities, and Authorities
RD&D	research, development, and demonstration
REX	recovery extraction
RP	Radiation Protection
SCAPA	Subcommittee on Consequence Assessment and Protective Actions
SD	Seismic Design
SDC	seismic design category
SDOR	saltless direct oxide reduction
SMP	safety management program
SOX	special oxide production
SQUG	Seismic Qualification Utility Group
SS	Safeguards and Security
SSCs	structures, systems, and components
UPF	Uranium Processing Facility
UPO	UPF Project Office
Y-12	Y-12 National Security Complex

Executive Summary

On 15 January, 2014, Acting Administrator of the National Nuclear Security Administration, Bruce Held, requested Thom Mason, director of Oak Ridge National Laboratory (ORNL), to lead a “project peer review” of the Uranium Processing Facility (see Appendix A). Twenty-five reviewers were recruited from across the US Department of Energy and National Nuclear Security Administration enterprise to conduct the study and this team was supported by subject matter experts from ORNL and informed by contractor and federal staff from the Y-12 National Security Complex (see Appendix B). The review was initiated by video conference on February 25 with Acting Administrator Held. During the week of 1 March 2014, the team was provided approximately 500 pages of read-ahead materials, and attended briefings and tours at the Y-12 Complex, resulting in approximately 400 pages of briefing materials and data sheets during the week of 10 March 2014. Then the team went home for a week of reflection, formulation, and thinking. During that time the team gathered and readied additional information for the following week of activity. The team then reassembled in Oak Ridge the week of 24 March 2014 to finalize their data, conduct remaining interviews (see Appendix C for list of presentations and interviews), and to formulate the response. The reviewers broke into four teams to evaluate the questions posed in the Charge Letter: “Missions and Management; Strategy and Operations; Technology; and Requirements Impacting Cost.” This report documents the results of that review. The Y-12 team has recently been exploring possible alternative strategies, and our proposed approach incorporates much of this thinking, with some important changes in organizational approach, mode of operation, and process definitions that we believe will be necessary for success.

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Overall Recommendations

Based on the Project Peer Review Team's observations and evaluation, a number of near-term recommendations and actions related to the overall enriched uranium mission have been identified.

Operational Risk Reduction and Management

In the current configuration, significant program risk exists in the ability to safely execute the uranium missions. The delay in the Uranium Processing Facility (UPF) project schedule and the increasing baseline cost exacerbates these issues and necessitates the ongoing use of existing facilities at the Y-12 National Security Complex (Y-12) for the foreseeable future. To enable the "going forward strategy," near-term actions are necessary to reduce safety and operational risk in existing facilities while the new build(s) proceeds. These actions will include aggressive inventory reduction [e.g., movement of materials to reduce Material at Risk (MAR) as defined by the facility safety basis] making full use of the Highly Enriched Uranium Materials Facility (HEUMF) as a storage and staging facility, reinvestment to ensure operations continuity (e.g., much of the aging equipment has significant deferred maintenance and has unacceptable downtime), and other operational optimization (e.g., relocation of certain process operations to other Y-12 facilities as subprojects within the overall mission strategy).

Sustaining Operations to Support the Enduring Enriched Uranium Mission

The US Department of Energy National Nuclear Security Administration (DOE/NNSA) must create an overarching enriched uranium mission strategy [see the program requirements document (PRD) recommendation in "New Build Project Scope Definition"] based on people, plant, process, and materials that takes into account both the current and future program demands and the condition and predicted life of current facilities and processes. This plan should be updated annually (potentially at the same time that the production and planning directive is issued). The plan must include an evaluation of "resilience," including a plan(s) for possible recovery routes to program upsets and potential loss-of-capability scenarios. The strategy should include periodic "make vs buy" options for the provision of capabilities, especially for material disposition and supply. For example, U-Mo alloy fabrication capability is a pending, nondefense mission that could potentially be outsourced to commercial industry.

New Build Project Scope Definition

Design efforts on the current "big box", single structure UPF concept should be stopped while a comprehensive reevaluation of program requirements and applicable design standards is undertaken, along with an evaluation of projected funding, to provide a firm revised project baseline. There are three distinct elements of the design that must be considered:

1. Many unit operations envisaged for the current UPF design will not be incorporated in the revised approach, and "new build" design efforts on these elements should stop.
2. Some unit operations envisaged for the current UPF design will be deployed in existing facilities within Y-12; design efforts should be redirected to support this new approach.
3. Some unit operations envisaged for the current UPF design will need to be deployed in "new build" facilities; design efforts can continue if they are focused to segregate operations by hazard and security category between the new builds, reflect the smaller footprints needed, and build on the UPF experience with regulatory issues.

The ownership of the project and the overall enriched uranium mission should reside with a senior career executive from the DOE/NNSA Defense Programs Office (NA-10) who has responsibility and authority for the PRD. This career executive must own and accept all of the requirements and must focus in particular on those that are significant cost and schedule drivers (e.g., seismic considerations) and the associated risks. In parallel with Enriched Uranium Mission (EUM) PRD finalization, elements of the UPF team could be dedicated to (1) developing designs and preliminary estimates for recapitalization of existing facilities and process systems to be relocated from 9212 and (2) initial planning and estimating for the rescoped new builds. In the interim, both components are essential to facilitate the proper sizing of the new build project and should be quickly undertaken within the scope of the UPF preliminary engineering and design budget. Ultimately, greater flexibility in moving resources (the budget allocation) between new build, existing facilities, and program operation accounts will have to be part of the EUM strategy with the balance between the accounts managed by the program executive.

Missions and Management

The Uranium Processing Facility (UPF) must be considered in the context of the broader enriched uranium stewardship mission. A program requirements document (PRD) encompassing this mission must be developed and issued under the ownership of the US Department of Energy National Nuclear Security Administration (DOE/NNSA) Defense Programs Office (NA-10). The PRD could take the form of an update to the UPF PRD; however, it would not be specific to a particular facility. Rather, it should specify a set of requirements to satisfy mission need across all facilities in the uranium system at Y-12 for it takes the entire system of linked uranium facilities to deliver on uranium missions. The mission-specific PRD would be used to validate the overall facilities strategy, which includes utilization of existing facilities, relocation of current processes that are at risk, and a new build(s) to meet long-term mission readiness requirements with acceptable risk for a subset of critical operations. As new facility acquisition investments are conceived to meet gaps in mission needs, facility-specific PRDs would be issued to document the government's risk tolerance and thus the maximum regulatory envelope allowable during design and construction. A single senior NA-10 career executive with full responsibility and authority to make decisions that balance risk and resources, should own the enriched uranium mission (EUM) and the PRDs. Both the operational rebalancing at the Y-12 National Security Complex (Y-12) and construction of required new facilities are components of this mission and fall under this responsibility envelope. This represents a change in approach compared to the current operating model.

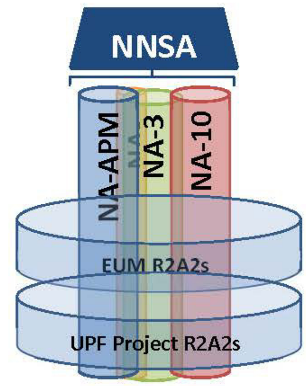

Figure 1. The new strategy will require engagement and matrixing of numerous NNSA offices.

Given the condition of some of the existing facilities and the 2025 time line contained in our charge, these actions must be taken without delay. The scope of the overall EUM and the strategy to achieve mission success overlaps multiple offices and will require integration and coordination. The new approach will create a complicated, highly matrixed organization that will require engagement of numerous NNSA offices, and hence the need for senior leadership (see Figure 1). Such a highly matrixed organization to achieve the mission will necessitate a strong culture of communication that assures open exchange of information across the EUM mission, particularly related to informing the balance of risk and cost.

Managing these interfaces is critical to program success, and the Review Team observed several conflicting opinions as to how these interfaces are currently being managed; the majority of senior management noted that substantive improvement is required. The "Concept of Operations" document for DOE/NNSA Acquisition and Project Management (NA-APM) organization provides a framework for developing Roles, Responsibilities, Accountabilities, and Authorities (R2A2s) for managing these interfaces, but ultimate responsibility is unclear during the current phase of project definition and design. The Project Execution Plan describes a gradual shift in responsibility from NA-10 to NA-APM as CD-2 is approached. However, the project has been "approaching" CD-2 for many years, and having a transitional authority has led to some confusion. As an example, the Program Office (NA-10) issued guidance to the project to utilize electro-refining/direct electrolytic reduction (ER/DER) as the project baseline technology for metal purification in January 2014. As of now, NA-APM has yet to concur with this direction, bringing into question who owns the baseline design requirement and creating a need for resolution by the Administrator.

The new Y-12/Pantex management and operating (M&O) contractor structure mirrors the current bi- (tri-, quad-) furcated (NA-10, NA-APM, NA-00) approach to ongoing operations and construction. The primary role of the M&O contractor should be to serve as the educated, demanding customer representing the EUM owner. In order to execute that role, the M&O contractor must manage three functions: optimization of scope; maintenance, operation and improvements to the site; and execution of design and construction of the new facility(ies). The new contract is organized around the latter two functions, leaving open the question of optimization. There are some potential competing interests between these functions that must be managed so that the M&O contractor is principally focused on scope optimization and long-term stewardship and is able to regulate requirements transmitted to the design team. Having the M&O contractor self-perform architect-engineer/construction-management functions is not often employed for large projects in other elements of DOE. Following Critical Decision (CD) 2 or 3a, it is appropriate for a major construction project to operate with considerable autonomy from an ongoing M&O operation due to the need for a schedule-driven, project-focused organization. As currently structured, neither NNSA nor the contractor are equipped to successfully deliver EUM outcomes that have a much greater degree of interdependence than was envisaged in the original UPF single facility concept or in the separation of Contract Line Item Numbers 1 and 2. This original project concept had a number of attractive attributes, but the urgency of need to reduce risk and affordability concerns have driven this analysis of alternatives. The EUM will require tradeoffs between elements in a constrained budget environment, and it will not be possible to resolve those issues without clear decision authorities in both NNSA and the M&O contractor. Y-12 should have a position at the level of deputy plant manager aligned to the responsibility of the EUM as described above who acts on behalf of the program as an educated, demanding customer. Incentives for individuals (federal and contractor) and the new M&O contract should be structured to encourage overall optimization of scope and performance in the most cost-effective way.

Managing this new strategy will require significant oversight and involvement from the EUM owner with appropriate, *ongoing* engagement from external parties. The current UPF Project has been subject to numerous reviews. Unfortunately, many of these reviews have been conducted as discrete events with minimal overlap and continuity between reviews. These reviews have not been effective at course-correcting the overall direction of the project nor at integrating the project with the ongoing enriched uranium program.

The complex nature of the EUM strategy recommended here requires a different approach building on some initial project steps to regularize reviews. There is significant benefit from sustained engagement by an independent review group composed of personnel familiar with the EUM strategy but not involved in the day-to-day operations of Y-12 or the project. This mirrors the successful approach employed by the Office of Science in its “Lehman Review” process. These reviews would be chartered by the EUM program official on a semiannual basis and examine the cost, scope, schedule, risk, and technical aspects of the effort, drawing on expertise from across the DOE complex. The Review Team would ensure that the risk tolerance documented in the facility-specific PRD is adhered to, preventing a default to more conservative interpretations of regulatory requirements to satisfy an aggressive build schedule or pressure from oversight organizations.

In addition, Y-12 should establish an EUM Technical Advisory Committee that would meet at least annually and report to the plant manager. The committee should include appropriate subject matter expertise to review both process design activities, Plant Directed Research and Development investments, and progress in areas such as ER/DER and the revised special oxide production (SOX)/aqueous processing approach described in the technology section of this report. These two new review and advisory bodies should replace, not augment, what has been more ad hoc and targeted reviews up to this point.

The Review Team recommends the following mission and management goals:

1. Establish an NNSA EUM owner with the responsibility and authority to develop and execute the approved EUM strategy.
2. Develop and issue an EUM strategy that recognizes the critical nature of this mission while balancing fiscal realities that require a recapitalization of existing facilities and simultaneously designing a new build(s) targeted toward critical unit operations. This should be codified in a mission PRD that is not limited to a single facility.
3. Fully develop and issue the NA-APM concept of operations document with approval by all affected NNSA offices at the deputy administrator level. This would apply to the new build construction activities and possibly to process relocation subprojects and would remove any ambiguity in ultimate responsibility, particularly prior to the start of construction.
4. Ensure that the new M&O contract, currently being negotiated, is structured and incentivized to result in an optimization of Y-12 activities in support of the EUM.
5. Develop and implement an ongoing review process for the EUM strategy that provides sustained oversight and resources for successful execution of the mission.

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Strategy and Operations

The principal recommendation in Strategy and Operations is to pursue a strategy of mission risk reduction while sustaining safe and secure highly enriched uranium (HEU) capabilities through three primary means:

- Accelerate risk reduction actions in all existing enriched uranium (EU) facilities through program operations.
- Maximize the use of existing facility space to relocate and/or replace 9212 capabilities.
- Acquire smaller, segregated space for those required 9212 capabilities that are inappropriate to be relocated to existing facilities.

This strategy is summarized graphically in Figure 2, in which the relocation of current major building 9212 capabilities are mapped, and is further described in more detail in the following subsections.

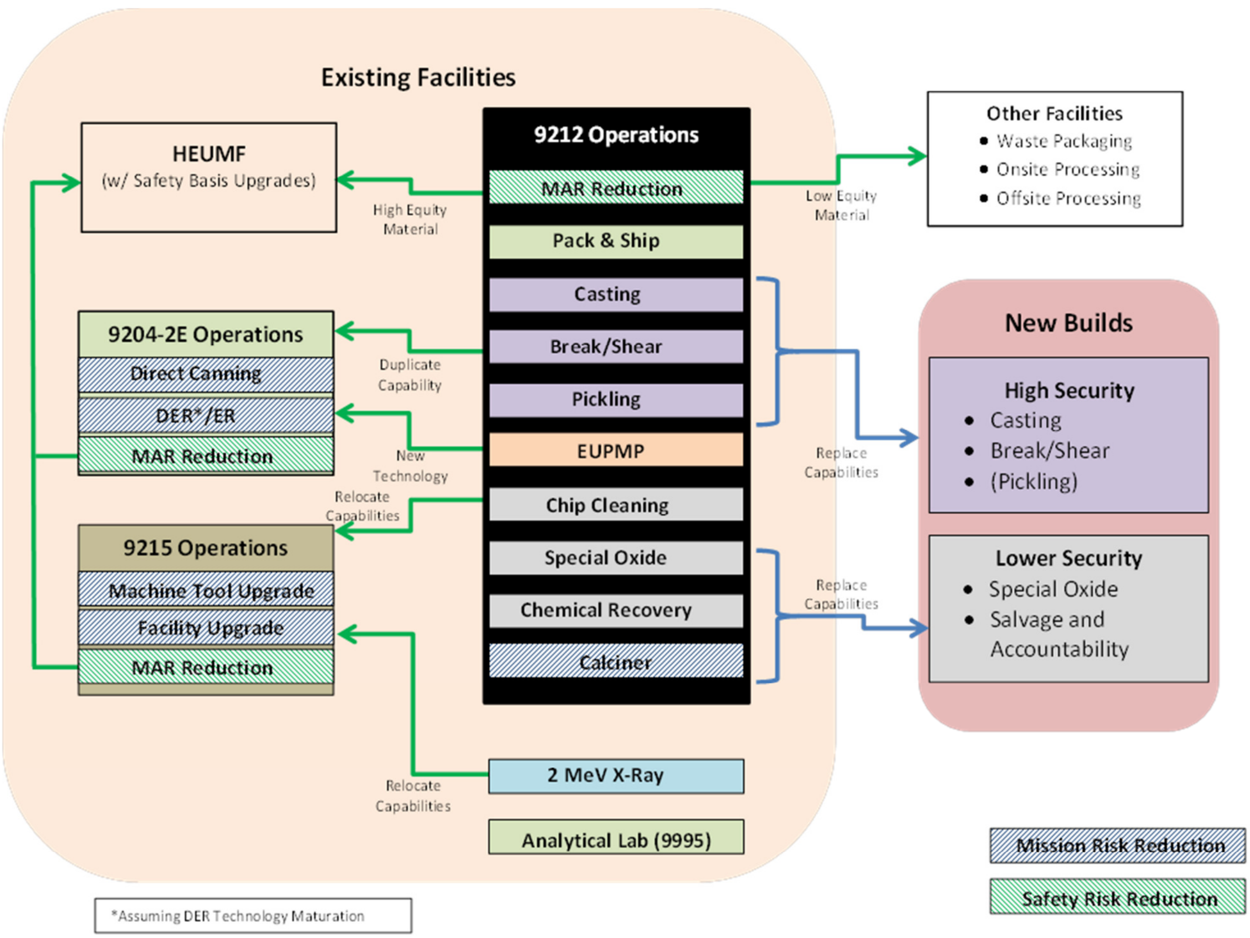

Figure 2. Mapping of existing 9212-related activities for transition.

Consistent with the approach described by the Mission and Management team, resource sharing between safety and mission risk reduction and new build investment should be managed by one central authority that is empowered to move resources between the objectives (see Appendix D for a discussion of the funding approach). This NA-10 career executive is accountable for balancing the risk between mission execution, safety, and security. The safety and mission risk reduction activities need to be carefully integrated with the new build(s) to create one cohesive EUM program.

Accelerating Risk Reduction

Consistent with the Y-12 building 9212 transition plans, aggressive actions need to be taken to reduce the Material at Risk (MAR) in 9212. To support this deinventory plan, a calciner should be installed in 9212 at the earliest opportunity to facilitate breaking the cycle of repurifying low-equity materials. Further study should be undertaken to identify additional steps that can be taken to minimize internal recycle and to facilitate disposition of legacy material with a minimum of handling. Given the current configuration, it appears that a large amount of effort is being expended to recover small quantities of material. This recovery is driving costs and increasing hazards; discarding the material may be preferred. MAR reduction in 9204-2E and 9215, as described below, should be undertaken urgently.

Appropriate Use of Existing Facilities

The Review Team assessed the utilization of existing facilities and recommends that the 9204-2E facility be designated as an enduring facility (at least 25 years) and that the 9215 facility be designated as an interim facility (less than 25 years) so that the current HEU capabilities can be sustained while being transitioned out of the 9212 facility. Space within 9204-2E (prime) and 9215 (secondary) needs to be used for the essential 9212 capabilities that are compatible with those spaces.

To continue the use of 9215 and 9204-2E for an extended period of time and enable the relocation of select 9212 operations, investments need to be made in the facility infrastructure and programmatic equipment in these facilities. While each facility has some unique risks, the highest areas of vulnerability in facility operations for both buildings are heating, ventilation, and air conditioning (HVAC); electrical; and structural. In addition, both facilities face a substantial investment in the replacement of fire suppression sprinkler heads that will soon reach their 50 year life. Appendix E includes a summary of the sustainment requirements based on assessments conducted in the Facility Risk Reduction evaluation (FRR II) and each facility's Operations Plan for Sustainment Activities. From a production standpoint, it is imperative that the production equipment and support systems in each facility be maintained and upgraded as necessary to sustain operations in these facilities for an extended period. For 9215, the highest areas of operational challenges in production operations are process exhaust systems and obsolete machine tools and controllers. For 9204-2E, the highest areas of operational challenges in production operations are environmental room controls, redundant capability in specific areas, and critical spares for major production process equipment.

To maximize the use of existing facilities and to reduce current risk, the HEUMF safety basis needs to be expanded to more readily receive inventory from other Y-12 facilities, most notably Building 9204-2E. The safety basis updates and movement of materials should be done with utmost urgency, leaving minimum (near just-in-time) inventories in 9204-2E and 9215 for efficient operations. With the space made in 9204-2E from this deinventory, ER and DER should be installed in 9204-2E, with the installation of DER delayed to support the technology selection decision as discussed in the Technology section.

To optimize productivity and efficiency during the period when existing facilities are being used, it is recommended that supporting processes be co-located with their associated production operations. Specifically, chip cleaning should be added to 9215, direct canning and break/shear should be added to 9204-2E, and machine tools in 9215 should be upgraded. Elements of the existing UPF design team can be dedicated to developing designs and preliminary estimates for capability relocations. The 2 MeV radiography should be relocated to 9215. It is also recommended that a joint US/UK evaluation be performed to evaluate use of dry machining to minimize or eliminate liquid coolant waste streams. The analytical lab capabilities in 9995 should continue to be used and not relocated or replaced.

New Build(s)

The remaining capabilities in 9212 that need to be relocated into new facilities are

- casting (including break/shear and pickling);
- chemical recovery (evaporator, decontamination, and calciner processes); and
- special oxide processing.

The acquisition of new facilities for these capabilities needs to be planned and executed consistent with the approach described in the "Requirements Impacting Cost" section, specifically, the segregation of unit operations by hazard and security classification. As previously mentioned, design efforts on the current single facility UPF design should be stopped and redirected while a reevaluation of the requirements and how they are applied is undertaken. Elements of the existing design team can be dedicated to developing designs and preliminary estimates for capability relocations. The time frame for this proposal is set out in Figure 3.

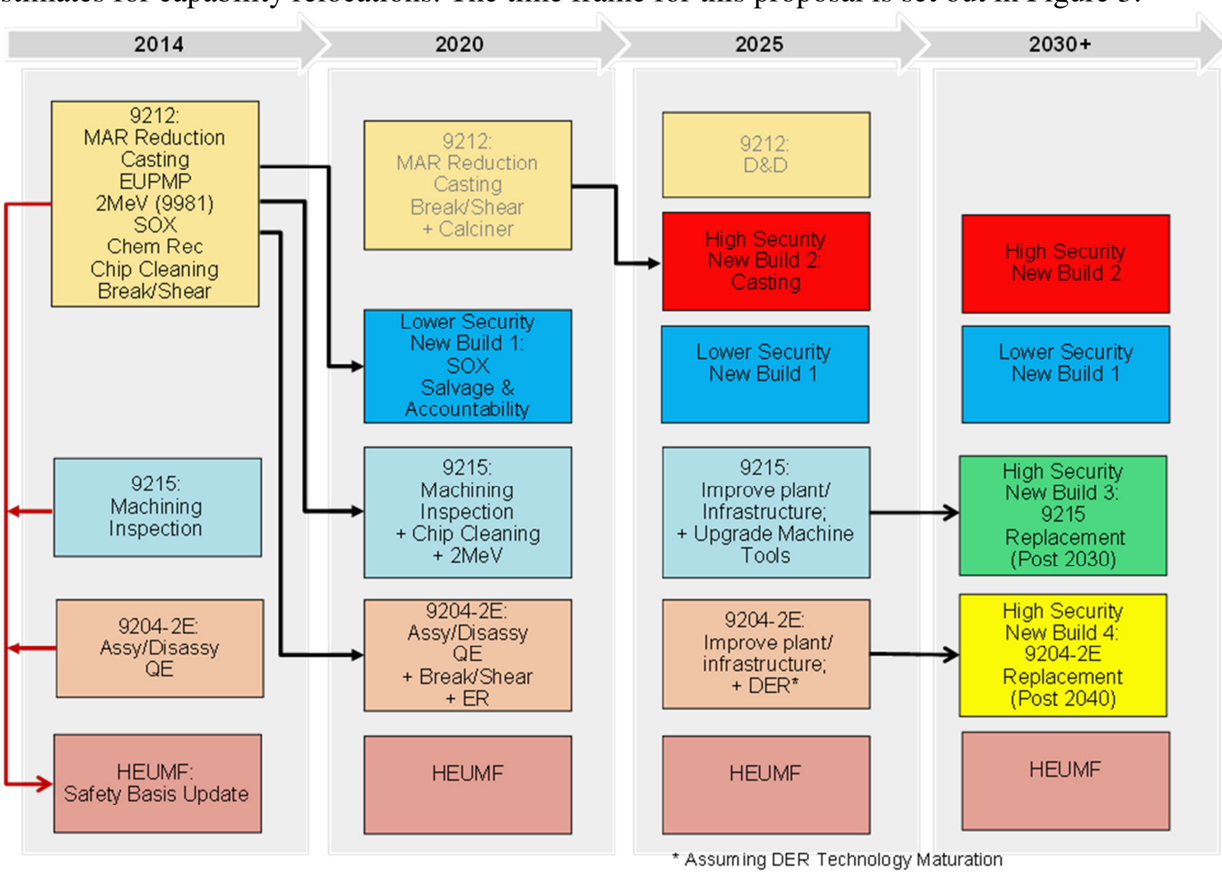

Figure 3. Proposed transition time frame.

A preliminary evaluation of the safety hazard category and security category of each of the unit operations relocating from 9212 was performed by the Review Team (see Appendix F). Based on this preliminary evaluation, casting should be relocated to a new high-security facility.

The number of casting furnaces needed should be reevaluated and optimized to the minimum required consistent with the overall revised EUM PRD requirements for defense missions. The Review Team preliminary judgement is that an initial complement of three casters is sufficient to meet these needs. However, space for additional casters should be included in the new facility design as a possible contingency. The space for the full complement should be built but the procurement and installation of the remainder retained as a scope contingency pending later determination of mission needs such as the planned U-Mo casting, prospects for canned subassembly recycle, and other higher-priority operational needs for this high-value space that might arise as a better understanding of resiliency in the existing facilities is developed. The procurement could be structured with option dates later in the schedule for final decision. In addition, an evaluation with the customer(s) should be undertaken to see whether pickling could be eliminated from the casting process so that the liquid waste generated could be eliminated.

The current Chemical Recovery capability would be more aptly named “Salvage and Accountability” in the new build concept. Enduring liquid waste streams need to be minimized as the recommendations from the Review Team are acted upon through a disciplined waste minimization program. Aqueous processing will continue to be an important part of chemical recovery. However, the chemical recovery systems should be re-evaluated in the context of the new configuration of processing and purification operations, and recovery processes no longer required should be eliminated. Consistent with the discussion from Y-12, the enduring salvage operations (currently performed by Chemical Recovery) should be redesigned to be in a lower hazard facility outside of an MAA, and Special Oxide should be included in this lower hazard facility referenced above with the process performed at lower inventory limits.

Special Oxide processing flow sheets and processing should be examined consistent with the recommendation from the Technology team to minimize the equipment necessary to provide processing flexibility. In addition, this process should be evaluated to determine if it can be performed with inventory limits (less than 20 kg) to allow processing outside of a security material access area (MAA). The team recognizes that feed preparation steps and final product handling will require significant changes.

Technology

Process Technology Assessment

The focal point of Y-12 enriched uranium operations is production of uranium metal for the assigned missions. Additional requirements exist for uranium oxide production. Supporting these are processing capabilities: mainly aqueous-based technologies for purification, conversion, and waste management. Y-12 is presently working on the development of new technologies that may benefit the overall EUM. Within the framework of this Review Team recommendations, these capabilities will be deployed in a combination of new builds and repurposed existing facilities. The Technology team process assessment was conducted without restriction as to the ultimate facility location.

Much excellent process-engineering work has been done for UPF. Y-12 has made progress on a number of new technologies and has advanced some systems (e.g., microwave melting/casting) to the point of deployment in the existing production facility. Nevertheless, the processing system architecture for future uranium processing missions has not been completely defined yet, and there are significant disparities between levels of design detail resulting from differences in technology readiness among specific unit operations. Until demonstrations are concluded, these differences in design maturity may result in inaccurate comparisons between competing technologies. This could lead to perceived advantages in terms of deployment and life cycle costs that would not be realized. The remaining uncertainties range from process selection and throughputs to definition of systems and hardware, and timely resolution is essential. A concern to the Review Team is that the facility design may have already outpaced the process design in key areas.

Enriched uranium metal processing (production/melting/casting) is the backbone mission. The preferred microwave melting/casting approach that is being developed to replace vacuum induction melting is still evolving in its deployment by Y-12 and certification by the weapon design laboratories [Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL)]. Installation of a production unit in existing facilities, as noted above, should expedite certification. With respect to the production of uranium metal, there is no fully accepted replacement for the current UF_4 bomb reduction approach. Replacement technologies are under development for this operation and other support operations, but these technologies are at varying levels of maturity. An overview of some of the primary process technologies is given in Table 1.In some cases, the processes for the future missions will be operated in either a semicontinuous or batch mode compared to more continuous operation in Building 9212. This creates both challenges and opportunities.

This current technology review considered technologies in the context of

- how well the throughput requirements are defined for the future missions;
- how these throughput needs are aligned with technology selection and operational schemes; and
- how well the technologies can be used for a more immediate reduction of risks, especially in Building 9212.

Table 1. Process technology assessment

Dissolution, evaporation, solvent extraction (contactors), precipitation	Calcination	Electro-refining (ER) and ancillary operations (e.g., UCl_3 synthesis, salt recovery, metal washing)	Direct electrolytic reduction (DER) and ancillary operations and saltless direct oxide reduction (SDOR) comparison
Straightforward adaptation to mission	Limited work remaining to qualify for project	Work remaining to qualify for project	Work remaining to qualify DER for project.
Adequate information exists to proceed with detailed design	Adequate information exists to proceed with detailed design	Proceed with research, development, and demonstration (RD&D) effort. Facility and process conceptual designs should be closely integrated with RD&D effort.	Proceed with DER RD&D, focused on process testing and equipment design modifications. Facility and process conceptual designs should be closely integrated with RD&D effort. SDOR work is on hold pending comparison with DER.

Technology Recommendations

- Reduce the number of aqueous purification systems to simplify operations, improve the safety basis, and reduce footprint and costs (see Appendix G).
  - Currently, even with proposed changes in chemical processes, the process flow diagrams approved for design include multiple aqueous purification lines [e.g., recovery extraction (REX), primary extraction (PEX), SOX].
  - The ER process will provide significant metal consolidation and purification capability.
  - The remaining demand for aqueous purification appears small compared to the capacity of a practical system.
  - It appears that the SOX aqueous line could be transformed (with some additional stages) into a multipurpose, robust purification system capable of meeting REX and PEX process requirements and replacing those systems. The revised SOX process could be operated in a campaign mode to meet additional purification needs and to provide for contingencies.
  - Aqueous purification processes planned for the new facilities are characteristically low holdup/low inventory, and throughputs will be less than historical requirements for some streams. In addition, all of the planned solvent extraction systems utilize equipment designed for continuous, long-duration operation, and each has far greater capacity than is needed for projected demand. Campaigning of material purification operation should be evaluated as a means of maximizing system utilization. Processing logistics, just-in-time transfers and other aspects of materials management should be optimized to capitalize on these features, with the objective of locating this system in a lower hazard nuclear facility. It is recognized that this is a significant challenge but the Team strongly believes it should be evaluated.
  - Thorough consideration needs to be given to methods for eliminating as many chemical recovery operations as possible. The aforementioned SOX modification should strive to minimize solvent U content and frequency of disposal in order to eliminate the need for organic treatment.
- Utilize the Y-12 EUM Technical Advisory Committee and the EUM independent review team as recommended by the Missions and Management Team to maintain ongoing reviews

of the development, demonstration, and implementation of processes to be used in the facilities. Confirm the process/unit operations selections and operational modes based on demonstrated process maturity, validated throughputs for future missions, opportunities for process simplifications, and availability for near-term risk reduction programs.

  - Continue the high-priority activities to advance the technical maturity of ER and its ancillary processes.
  - Continue the high-priority activities to advance the technical maturity of DER, define DER ancillary processes, and compare DER with saltless direct oxide reduction (SDOR).
  - Review peripheral operations to determine if they can be significantly reduced or eliminated, considering requirements for the future missions (e.g., uranium recovery from spent solvent). This would provide cost, operational, and safety benefits.
  - Review processes for consistent application of uranium recovery guidelines in light of the smaller throughputs anticipated for the future and current program/policy.
  - Provide capability for small special operations for processing miscellaneous material.
  - Ensure that process evaluations are comprehensive (e.g., life cycle costs, safety, footprint, operating maturity, waste production, interfaces).

- Expedite technology transfer and translation. Important technology development and demonstration work remains to be done in support of the EUM. To accomplish this, Y-12 must increase technical interchanges with the broader DOE complex to further accelerate the development and deployment of new technologies. Y-12 has made strides in this area over the past few years, but additional focus is needed to accelerate the technology transfer.
  - Establish working relationships with technical experts outside Y-12, including exchanges of staff.
  - Consider options for obtaining additional research, development, and demonstration (RD&D) project support from outside Y-12.
- Align the technology development and certification plans and schedules to support the timely and seamless integration of new technologies into the new facilities.
  - Greater cooperation and closer integration between Y-12 and the design laboratories (LANL and LLNL) is required to ensure the timely introduction and approval of any new technologies.
- Focus detailed design work according to the maturity of the process technology.
  - The Review Team believes detailed design may beneficially proceed for aqueous chemical recovery, special oxide production, and microwave melting/casting.
  - Detailed design on other processes should be paced by the maturity of the technology and the availability of sufficient design bases. Detailed design on oxide reduction should await a selection between SDOR and DER.
- Evaluate other technologies. This assessment has focused on process technology; however, evaluation of new technologies in other areas may provide concomitant benefits in terms of processing. For example, dry machining may offer potential benefits, including eliminating the coolant stream.

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Requirements Impacting Costs

The objective of the team was to identify requirements cost drivers with major impact to project cost, scope, and schedule. The areas reviewed included: Nuclear Criticality Safety, Seismic Design, Chemical Safety, Fire Protection, Industrial Safety, Radiation Protection, and Safeguards and Security (see Appendix H). Based on information acquired during this effort, the major requirement drivers affecting facility cost are the seismic requirements associated with criticality safety and chemical toxicity. Safeguards and Security, Industrial Safety, and Radiation Protection requirements, while they impact total project cost, are not nearly as significant as the cost drivers related to the compounding requirements due to the hazards involved in the single facility UPF approach.

Decisions related to the identification, interpretation, and application of requirements are being made at various levels of organizations and authorities and may not consider the potential impacts to project cost, scope, or schedule. The number of such influential decisions makes it difficult to implement a graded approach with a clearly defined “risk-informed” perspective. Within the current UPF project, preliminary regulatory design requirements were interpreted according to the more restrictive and conservative application of the requirements within 10 CFR 830.202(b)(3), DOE-STD-1027-92, and DOE-STD-1189-2008 while meeting an aggressive CD-1design schedule. Some requirements were also negotiated and concurred upon by project review organizations (i.e., UPF Design Team; US DOE Office of Health, Safety, and Security; the Defense Nuclear Facilities Safety Board; DOE Central Technical Authority, and others) with limited to no consideration of overall program risk (e.g., cost, operation efficiency, and allocation of resources for overall integrated safety).

The restrictive design requirements resulted in excessive quality and safety analysis requirements beyond actual needs. Examples include the following requirements:

- Requiring welded pipe joints in all the fire suppression systems, exceeding standard National Fire Protection Association (NFPA) requirements.
- Strict implementation of the ANSI/ANS-8.1-1998 ¶4.2.2 Double Contingency Principle (DCP) to meet criticality safety requirements of DOE Order 420.1B Chg1 instead of pursuing justified DOE Secretarial Officer approval of situations that could result in departures from the DCP (i.e., DOE O 420.1B, 5.b.(6)) thereby permitting the performance of an ANSI/ANS-8.1-1998 ¶4.1.2 Process Analysis to justifiably demonstrate effective alternative approaches for safety such as active engineered and administrative controls as opposed to passive engineered controls.
- Defaulting to the highest level as defined by DOE-STD-1189-2008 to meet CD-1design schedules without conducting supporting analyses and exemption requests that may have reduced costly requirements.
- The current design applies conservative regulatory requirement assumptions to many portions of the facility and equipment within, resulting in increased costs for procurement, installation, maintenance, and testing. As an example related to procurement, the cost of components to meet NQA1 requirements (Q Factor) is significantly greater as compared to a commercial application (e.g., HVAC dampers cost ~5 times more, instruments cost ~4.5 times more, pumps cost 2.8 to 5.6 times more). Past efforts indicate that the equipment is often the same but significant supplier costs are incurred when NQA-1 is imposed in the suppliers’ contract. Additionally, when products are purchased to commercial standards, significant engineering, destructive and non-destructive testing costs are incurred to follow

the NQA-1 commercial-grade dedication provisions toward crediting the system to a higher performance category.

- Decisions to impose stringent requirements for safety structures, systems and components (SSCs) throughout the entire facility based on a potential toxicological hazard. If the hazard was not located in a nuclear facility, the added requirements would not be imposed for the same potential toxicological hazard in a nonnuclear facility.
- Various operations with different requirements have been commingled within a single facility design (i.e., UPF big box), thereby establishing excessive design and procurement requirements for non-safety equipment and materials.

Reevaluation and relaxation of requirements related to seismic design category (SDC) and limit state (LS), while ensuring appropriate risk mitigation, reduction, and acceptance, will result in cost and schedule reduction. Furthermore, the use of experience-based data, for example, within the Seismic Qualification Utility Group (SQUG) database would save cost for seismic qualification of equipment, and in some cases would eliminate the need for seismic analysis. This approach would result in a reduction in overall costs associated with procurement, installation, maintenance, and testing.

Separate new build facilities offer the opportunity to segregate and limit the regulatory requirements that relate to significantly different hazards, consequences, and security categories, eliminating the artificial escalation of requirements from nonrelated hazards.

Recommendations

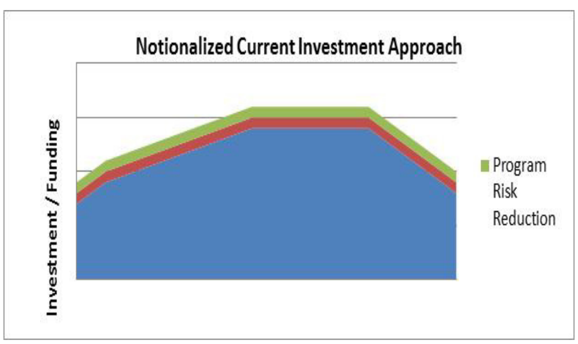
- Move from a single building “big box” design for EU operations and use separate new building designs that will enable the removal of requirements that no longer apply to the recommended lower hazard category facilities with lower security needs.
- The new build design team should
  - urgently review prior decisions regarding requirements assumptions;
  - identify high-impact, high-cost requirements where overly conservative decisions were made due to time constraints (e.g., decisions made prior to sufficient information on building design or technology process was available) or influence from external reviewers;
  - evaluate the risks and impacts to cost, scope, schedule, and program requirements and
  - provide recommendations to the EUM career executive.
- The DOE/NNSA senior career executive should ensure that decisions made in the previous recommendation are cost-informed and risk-based decisions made early enough to impact key design elements. After the effects on project cost and schedule, mission, or scope have been evaluated, the decisions may be to accept a conservative assumption and associated effects or to accept additional risk associated with a less conservative assumption. These decisions should be documented in facility-specific PRDs prior to CD-2.

Summary and Conclusions

This Review Team has concluded that a wholesale recapitalization of the enriched uranium capabilities at Y-12 within a single "big box" facility, while possessing some attractive characteristics in terms of footprint reduction and apparent operational simplicity, comes at a very high cost due to imposing the most stringent and expensive safety and security requirements on all operations, even in cases for which they are not applicable. The collateral impact of the high cost is the unacceptable delay in moving operations out of 9212, where the risk of interruption of mission will grow over time to a point where it cannot be sustained.

Even today, mission risks exist, and these risks must be addressed aggressively to insure continued safe and secure operations in the near-term while a different approach to sustaining the EUM is developed and implemented. The Review Team believes that Y-12 Building 9212 capabilities can be replaced within the funding constraints of $6.5B by using a combination of existing Y-12 facilities and a "new build" strategy of smaller buildings with separate hazard and security requirements.[1] To be certain, there is urgency in the need for new facility space to replace a set of 9212 capabilities, the construction of which must be completed post-haste.

Resource sharing between safety and mission risk reduction and new investment should be managed by one central authority that is empowered to move resources between the objectives. The existing funding profile which focuses the bulk of the available funding in the design and construction of the single "big box" facility will not allow execution of the necessary safety and mission risk reduction in existing Y-12 facilities. Therefore, it is necessary to integrate the safety and mission risk reduction activities with the new build(s) project. Notional views of the existing, and a proposed new funding profile is shown in Figure 4. Resource limitations may require the EUM executive to minimize the new build footprint and cost in order to remove the safety risks at 9212 and achieve continued success of EU operations within the $6.5B constraint. Stability in mission, technology, and regulatory requirements is also essential to assure success in the new build(s).



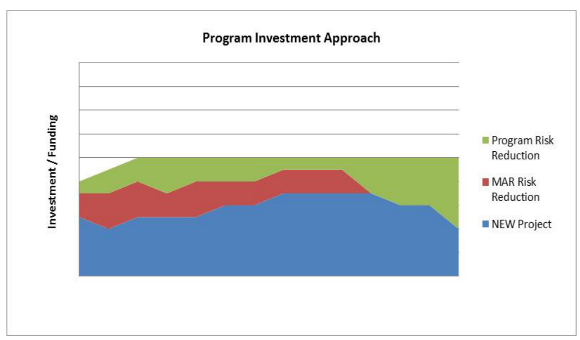


Figure 4. Risk-reduction profiles as shown notionally using existing (left) and proposed (right) EU investment funding over time.

In order to meet the stated goal to exit Building 9212 by 2025, the new strategy must be worked aggressively and a "fast-track" approach to traditional NNSA project management will

[1] Very rough order of magnitude assessments were developed using available data, and general cost estimating information for "new build" facilities [i.e., similar methodology to the Department of Defense Cost Assessment & Performance Evaluation process].

be required. The Review Team believes that the fast track approach can be implemented without assuming undue risk, but significant and sustained oversight will be required. The Review Team believes that successfully executing this strategy could help change the trajectory of the entire nuclear security enterprise, resulting in a robust, sustainable infrastructure necessary to deliver mission success.

An evaluation of this approach against the elements of our charge is shown in Table 2. Properly executed, we believe most of the desired outcomes are possible with two caveats.

Table 2. Assessment against charge letter

Result	Charge criteria
Green	Results in delivery of 9212 capabilities for not more than $6.5B
Red	Replaces 9212 capabilities no later than 2025
Green	Proximity to HEUMF and eventual consolidation in a campus-like concept
Green	Preferential reliance on engineered controls, and contemporary codes and standards
Green	Considers newer purification technologies
Yellow	Preserves existing design elements to the extent practicable
Green	Accommodates existing and planned site infrastructure
Green	Presents minimal disruption to site readiness/prep activities
Key:	
Green	Team has a reasonable confidence this was achieved
Yellow	Partial achievement of this tasking
Red	Demanding, but possible to achieve

The greatest concern lies with schedule, shown as red. All of the tasks needed to vacate 9212 (deinventory, relocate, and new build) are interdependent, tie to ongoing operations, and currently have different constituencies within Y-12 and NNSA. While it is certainly possible from a budget constraint and physical execution point of view to complete them all by 2025, it will be extraordinarily difficult without the revised management approach we have articulated. The other area of concern is design breakage (shown as yellow). There has been considerable effort and expense devoted to the preparation for the big box UPF, only some of which will be applicable if this alternative is adopted. All of the site preparation and readiness activities are essential to prepare a suitable location for the new build within the constrained Y-12 footprint. They should continue at full speed. Much of the process system design that has been completed for UPF will be applicable either for the new build processes or for processes to be relocated into existing facilities; elements of the design team can be redirected accordingly. The building design for the big box UPF contains concepts such as the gabion wall that will be valuable for the high-hazard, high-security new build facility albeit with a much smaller footprint; however, given the more limited set of operations to be included, there is significant opportunity to eliminate requirements (toxicity for example) that are no longer applicable. This is even more true for the lower-hazard, lower-security new build facility, for which the cost savings per square foot can be substantial. As a result, there is much in the current UPF facility design that will not carry over to the new facilities; however the Review Team is hopeful that much of the process design can be more readily used as the new build(s) proceed.

Appendix A. Bruce Held Charge Letter

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Department of Energy
National Nuclear Security Administration
Washington DC 20585

January 15, 2014

OFFICE OF THE ADMINISTRATOR

MEMORANDUM FOR THOMAS MASON

FROM: EDWARD BRUCE HELD
ACTING ADMINISTRATOR

SUBJECT: Uranium Processing Facility Project Peer Review

As the Uranium Processing Facility (UPF) project approaches the Critical Decision phase to develop a performance baseline, I am concerned about cost growth and budget constraint issues that have been brought to my attention. Accordingly, I am requesting that you comprise and lead a team of sufficient capability; to include representation from our weapons laboratories, to develop and recommend an alternative approach to the UPF Project, as presently defined, to meet the following objectives:

- Results in delivery of Building 9212 capabilities for not more than $6.5B;
- Replaces Building 9212 capabilities no later than 2025;
- Maintains proximity to the Highly Enriched Uranium Materials Facility and considers eventual consolidation of remaining EU mission capabilities with a campus-like concept to enable operational efficiencies and reduction of the Protected Area footprint;
- Preferential reliance on engineered controls and compliance with contemporary building codes and standards;
- Considers newer metal purification technologies with lower space demands;
- Preserves existing design elements to the extent practical;
- Accommodates existing and planned site infrastructure; and
- Presents minimal disruption to current site readiness/preparatory activities.

With full appreciation of the scope and difficulty of this tasking, given the mission risks presented by protracted occupancy in Building 9212, I ask that you provide your recommendation to me by April 15, 2014.

Per the Deputy Secretary's April 2011 policy on project peer reviews, there should be no contractual or budgetary impediments to accomplishing this cross-program review.

The Federal Project Director, Mr. John Eschenberg, will serve as your point of contact.

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Appendix B. Participants and Subject Matter Experts

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Participants

Tim Driscoll, DOE/NNSA NA-193

Mike Goff, Idaho National Laboratory

Connie Hall, Tetratech

Calvin Hopper, Consultant

Steve Howell, SRS

Susan Howell, Pro2Serve, Inc.

David Jones, Atomic Weapons Establishment, UK

David Kellock, Atomic Weapons Establishment, UK

Sue King, CB&I

Brett Kniss, Los Alamos National Laboratory

Bill Madia, Stanford University

John Marra, Savannah River National Laboratory

Thom Mason, Oak Ridge National Laboratory

Bob Merriman, Consultant

Chad Monthan, Sandia National Laboratory

Matt Nuckols, Los Alamos National Laboratory

Cecil Parks, Oak Ridge National Laboratory

Monica Regalbuto, DOE NE-5

Roger Rocha, Lawrence Livermore National Laboratory

Joe Sandoval, Sandia National Laboratory

Al Sattelberger, Argonne National Laboratory

Dwight Squire, Lawrence Livermore National Laboratory

Jimmy Stone, Oak Ridge National Laboratory

Derek Wapman, Lawrence Livermore National Laboratory

Ray Wymer, Consultant

Subject Matter Experts – Oak Ridge National Laboratory

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Jon Kreykes

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John O'Neil

Technical Resource Leads – Y-12 National Security Complex

John Gertsen

Tony Giordano

Mona Glass

NNSA Resource Support

Dale Christenson, Y-12 UPF Project Office

Ken Ivey, Y-12 NNSA Project Office

David Wall, Y-12 NNSA Project Office

Brief Biographies of Participants

Timothy P. Driscoll, Director, Science and Manufacturing Capabilities
Office of Defense Programs, NNSA

Mr. Driscoll joined the Department of Energy in 1983 in the engineering intern program at the Albuquerque Operations Office. He started his career as a Mechanical Engineer in the Weapon Development Division. Working in the Office of Process Development, he developed expertise in the unique materials and manufacturing processes utilized in nuclear weapons.

Tim also worked in Albuquerque's Production Operations Division managing the Master Nuclear Schedule for Plutonium, assuring its security and availability for production. Tim's weapon expertise and engineering background led him to weapon program management, where in the Weapon Programs Division he served as the lead system engineer on the W68 program.

Tim was selected as a supervisor, becoming Chief of the Technical Support Branch of the Transportation Safeguards Division. Here he served as the chief engineer for the safety and security of the specialty highway, rail and communication equipment used in safe and secure transportation of weapons.

Tim has served the Department in administrative roles also, as the Chief Learning Officer in the position of Director, Qualification and Training Division and as the Chief Information Officer as the Director, Information Resources Management Division. His engineering expertise led him next to be the Deputy Director, Office of Construction and Engineering Programs. He became a certified nuclear construction project manager, and managed program managers across the DOE.

In 2002 Tim returned to the nuclear weapon programs as the Director of the Nuclear Bombs Division. As the NNSA Program Manager for stockpiled bombs, he was responsible for their safety, security, reliability, and maintenance. In 2006, Tim successfully led the project which achieved First Production for the B61 Life Extension Program, successfully achieving this stockpile milestone.

In 2008, the NNSA Administrator selected Mr. Driscoll as the acting Associate Administrator for Defense Nuclear Security. In this capacity, he was responsible for protection of NNSA personnel, facilities, nuclear weapons, and information from a full spectrum of threats, most notably from terrorism.

Tim is now stationed in Washington, DC, where he continues to apply his weapon knowledge and experience in Policy and Management positions. He has managed the Readiness and Technical Base and Facilities program, responsible for the weapon complex enterprise facilities and infrastructure and a budget of nearly $2B annually. Most recently Tim led the Office of Nuclear Operations for Defense Programs.

In March of 2013, Tim was assigned as the manager for the newly created Office of Manufacturing and Science Capabilities. It is a perfect fit of his unique weapons and infrastructure experience and knowledge base. In this role he leads the establishment of Defense Programs capabilities for modernizing the nuclear stockpile through managing the investments in technology and construction.

He holds a BS in Mechanical Engineering from the University of New Mexico, and an MS in Mechanical Engineering from New Mexico State University.

K. Michael Goff, Director of the Nuclear Nonproliferation Division at Idaho National Laboratory, Idaho Falls, Idaho

Mike Goff received his Bachelor of Nuclear Engineering, Master of Science in Nuclear Engineering, and PhD in Nuclear Engineering with a minor in Chemistry from Georgia Institute of Technology in 1986, 1988, and 1991, respectively. The focus of his studies was the nuclear fuel cycle. His dissertation work was performed at Argonne National Laboratory.

Since 1988, Mike has held various technical staff and management positions at Idaho National Laboratory (INL), Argonne National Laboratory-West, and Argonne National Laboratory (ANL). He is presently Director of the Nuclear Nonproliferation Division at INL. Within DOE's Office of Nuclear Energy (DOE-NE), he is the Technical Lead for the Joint Fuel Cycle Study under the Fuel Cycle Research and Development Program. He has served in the following positions: INL Deputy Associate Laboratory Director for Nuclear Science and Technology, Technical Integrator for the DOE-NE Fuel Cycle Research and Development Program, Senior Technical Advisor to DOE Assistant Secretary for Nuclear Energy, INL Director Fuel Cycle Programs Division, ANL-West Deputy Director Engineering Technology Division, Director EBR-II Spent Fuel Treatment Program, researcher and manager for various fuel cycle related programs at ANL-West, and Laboratory Graduate Research Assistant at ANL.

Mike's career has focused on the nuclear fuel cycle including separations technology, high-level waste development, and safeguards. Much of his work was on the development and implementation of electrochemical processes for the treatment of used nuclear fuel. He has authored or coauthored numerous publications on the nuclear fuel cycle.

Mike is active in the American Nuclear Society (ANS). Within ANS he has served as Chair, Vice-Chair and Secretary/Treasurer of the Fuel Cycle Waste Management Division. He has also been active in the governance of the society. For national and international technical meetings, he has served the following roles: U.S. International Program Co-Chair, Global 2011; Technical Program Chair, Global 2007; Technical Program Chair, ANS Annual Meeting 2006; Technical Program Co-Chair, DOE Spent Nuclear Fuel and Fissile Material Management 2000; Assistant Technical Program Chair, DOE Spent Nuclear Fuel – Challenges and Initiatives 1994; and Assistant General Chair, ANS Annual Meeting 1996.

Connie P. Hall, Tetratech

Connie Hall has over thirty-five years' experience in technical and management positions in nuclear facilities. Ms. Hall's career began in 1976 at the Y-12 National Security Complex in the Nuclear Materials Control and Accountability (NMC&A) Department where she served in various capacities over a period of 14 years. In 1990 she became the manager of the NMC&A Department at the East Tennessee Technology Park (Oak Ridge Gaseous Diffusion Plant) and held that position through 1993.

In 1994 Ms. Hall was assigned the responsibility of managing the Surveillance and Maintenance Department. This organization was responsible for ongoing maintenance and oversight of the shutdown buildings formerly used for uranium enrichment processes. In 1997 Ms. Hall became the project manager for the Uranium Deposit Removal Project. In this position Ms. Hall was responsible for managing the efforts to remove deposits of enriched uranium from the process equipment. These deposits caused concerns for criticality and for security.

In 1998 Ms. Hall returned to the Y-12 National Security Complex as a program manager and managed several programs, including the Materials Recycle and Recovery Program and the program for indirect costs in the plant with an annual budget of almost $300M.

In 2001 Ms. Hall was appointed the manager of the NMC&A Department—a position she held until her retirement in 2006. Following retirement she worked for two years for Haselwood Enterprises, Inc., providing technical expertise to the NMC&A programs of the Y-12 National Security Complex and the Los Alamos National Laboratory. Since 2009 Ms. Hall has been involved in work at the International Atomic Energy Agency (IAEA) as a member of a working group that has developed guidance for a facility to use to design and implement an effective NMC&A program. She has recently become a member of a second working group that is developing a methodology for assessing the effectiveness of nuclear security programs (NMC&A, physical protection, etc.).

During her career Ms. Hall has received numerous awards, including the Lockheed Martin NOVA award for significant achievements in management in 1997 and the special service award from the Institute of Nuclear Materials Management in 2006.

Calvin Hopper, Consultant

Calvin M. Hopper retired from the Oak Ridge National Laboratory in 2008 as a Distinguished Development and Design Engineer in the Radiation Transport and Criticality Group within the Nuclear Science and Technology Division. In his continuing consultancy with C.S. Engineering, Hopper’s work has been extended with on-going work for ORNL contracts to the US DOE and US NRC and three years of consulting to the Oak Ridge Y-12 National Security Complex UPF Project as a senior nuclear criticality safety reviewer (2008–2011). Over the past 44 years, following his receipt of a B.S. in Physics from Southern Colorado State College, his job positions have included:

- Nuclear Criticality Safety Consultant with C.S. Engineering, Inc. (2008–2014)
- Distinguished Development and Design Engineer in the ORNL Radiation Transport and Criticality Group project managing the US NRC and US DOE sensitivity and uncertainty analysis project (1996–2007)
- Head of the ORNL Nuclear Criticality Safety (NCS) Section (1995–1996)
- Oak Ridge National Laboratory Nuclear Criticality Safety Officer (1985–1995)
- Head of the NCS Department at the Oak Ridge Y-12 Plant (1982–1985)
- Technical Manager of the Oak Ridge Y-12 Plant Health Physics Department (1980–1982)
- Head of Licensing, Nuclear Safety (Criticality Safety and Health Physics) and Nuclear Material Accountability at the Texas Instruments, Inc., HFIR Project Research Reactor Fuel Fabrication Facility, USNRC License Number SNM-23 (1978–1980)
- NCS Engineer at the Y-12 Plant and rotating staff member for the Oak Ridge Gaseous Diffusion Plant (1970–1978)
- Radiation Protection Officer for the Oak Ridge Critical Experiments Facility (1968–1970)

Current roles include:

- Charter Member, past Chair (1997–2013) and Emeritus member of the US DOE NCSP Criticality Safety Support Group
- Coordinator of the US DOE Critical and Subcritical Hands-On Training and Education Program (2011–2013)
- Over-all Advisor to ANSI for ISO Technical Committee 85 (Nuclear energy, nuclear technologies, and radiological protection) / Subcommittee 5 (Nuclear fuel cycle) (1995–2013)
- Convener (e.g., Chair) of Working Group 8 on criticality safety within Subcommittee 5 and Technical Committee 85 (1995–2014)

Past Professional activities included:

- US DOE Albuquerque Weapons Criticality Safety Committee
- Program Chair, Treasurer, and Co-Chair/Chair of the US ANS Nuclear Criticality Safety Division
- Chair of ANSI/ANS-8.7 storage standard and member of ANSI/ANS-8.1, 8.19, 8.23, 8.26
- Chair of the ANSI/ANS N16 Consensus Committee on Nuclear Criticality Safety
- Co-author of the US Department of Energy Nuclear Criticality Safety Program (NCSP) description and plan in response to DNFSB 97-2
- Manager of the US DOE NCSP ORNL tasking for the development of sensitivity and uncertainty analysis tools (AROBCAD and TSUNAMI).
- Consultancies to IAEA Nuclear Safety and Security

Awards/recognitions include:

- ANS Fellow Member status
- US DOE Under Secretary of ES&H citation for successfully managing the US DOE Plutonium ES&H Vulnerability Assessment for the US DOE Oak Ridge Operations Site Assessment and Team Report
- ANS Standards Service Award
- NNSA Certificate of Appreciation for the TRUPACT-II and HalfPACT systems criticality safety analysis
- American Nuclear Society Nuclear Criticality Safety Division Distinguished Service Award
- Colorado State University – Pueblo Outstanding Achievement Award

Steven J. Howell, Savannah River Nuclear Solutions, LLC

Steve Howell is the Deputy Director of Environmental Management Operations for Savannah River Nuclear Solutions (SRNS), which holds the management and operating contract at the Department of Energy's(DOE) Savannah River Site (SRS).

Steve has 25 years of nuclear experience since joining the Savannah River Site in 1989. His experience includes 15 years at the SRS F-Canyon plutonium production facility where he held positions of increasing responsibility including plant engineer, shift operations manager, operations manager, and engineering manager. After F-Canyon, he served as Deputy Facility Manager of the Liquid Waste Operations h-Tank Farm for two years before becoming the H-Canyon Facility Manager in 2006. He assumed his current position in 2011 which includes responsibility for operations in E-Area solid waste management, F&H Area nuclear materials processing, and nuclear materials storage in K and L Areas.

Steve is a graduate of the Institute of Nuclear Power Operations (INPO) five week Senior Nuclear Plant Manager course and has mentored INPO courses for managers and supervisors. He has presented multiple papers on safe operation of nuclear facilities including the American Nuclear Society national conference in Washington, D.C., the SRS Citizens Advisory Board, and the Defense Nuclear Facilities Safety Board (DNFSB). He has also developed and presented training materials related to radiological chemical separations for the International Non-Proliferation Export Control Program (INECP) sponsored by the Department of Energy National Nuclear Security Administration (NNSA).

He holds a Master's Degree in mechanical engineering from the University of South Carolina.

Susan Howell, Pro2Serve, Inc.

Ms. Howell has over 35 years' experience as a program director, project manager, organization manager and technical lead. Her technical and management experience includes management of environmental, weapons, and facilities and infrastructure projects and programs over a 31 year career at the Y-12 National Security Complex. Ms. Howell has a proven background in management and operation of nuclear facilities and infrastructure and is well versed in DOE Orders and other applicable regulations for nuclear facilities.

Ms. Howell's increasing responsibilities in facilities and infrastructure management at Y-12 culminated in her leadership role as Director of the Y-12 Readiness and Technical Base and Facilities (RTBF) Program. The DOE NNSA RTBF Program provides the physical infrastructure, materials, and personnel required to maintain operational readiness of the production facilities to consistently support mission deliverables. Ms. Howell led a team of Program Managers as well as a number of Project Managers to ensure continued availability of facilities and infrastructure, recycle and recovery of special nuclear materials, nuclear material storage and disposition, and infrastructure recapitalization investments. Ms. Howell's blend of business management, project management and leadership expertise were brought to bear on the challenges of managing an aging infrastructure within a confined budget as well as in developing and executing critical capital investments to ensure facility availability into the future. .

Ms. Howell's responsibilities as RTBF Director also encompassed leadership for the NNSA Facilities and Infrastructure Recapitalization Program (FIRP) at Y-12. The FIRP was developed by the NNSA to provide much needed investment into the aging physical infrastructure of the Nuclear Weapons Complex. In this capacity, Ms. Howell led the team responsible for developing and executing significant infrastructure investments at Y-12, including modifications/upgrades to existing infrastructure systems as well as design and construction of new support facilities and capabilities. Under Ms. Howell's leadership, the FIRP also successfully demolished over 1.2M square feet in over 280 excess facilities, freeing up valuable real estate for future modernization efforts and reducing utilities and other support costs.

After her retirement from Y-12, Ms. Howell has continued her support to the nuclear weapons complex through her employment with Pro2Serve. Capitalizing on strong technical and project management skills, Ms. Howell led a team of subject matter experts that provided the senior technical expertise in uranium processing and nuclear facility design, startup and operation as well as demonstrated understanding of project management in a DOE environment for the development of a comprehensive Independent Cost Estimate (ICE) of the Uranium Processing Facility (UPF). The comprehensive ICE, which included all aspects of project design, construction, startup testing and authorization, was completed within a compressed time schedule; during this time, Ms. Howell and her team led the effort to develop the project WBS, estimating methodology and integrated schedule.

Continuing to utilize her technical expertise in DOE facilities and infrastructure management, Ms. Howell also provided technical support to the Y-12 Infrastructure Programs, which encompasses NNSA RTBF program elements, FIRP, and key site infrastructure overhead programs. Most recently, she provided technical support and leadership in the development of the Material Recycle and Recovery (MRR) Transition Plan, a program-level document that lays out the strategy, business case, technology development and schedule for transitioning key nuclear material operations to more efficient, effective technologies.

David Jones, Atomic Weapons Establishment, UK

David Jones is Head of Production Operations, and deputy to the Director Production Operations on the AWE Plc Board, having previously been Head of Assembly & Explosives Operations at Burghfield.

He took on this role in May 2012 and his responsibilities include:

- Manage the Production Operations Function
- Maintain Production Operations strategic direction and plan
- Lead Production Operations transformation
- UK lead for UK/US Manufacturing and Production Steering Committee

David joined AWE as a Graduate Engineer in 1986, and has spent the majority of his career in high hazard operational roles. He has held a number of key senior leadership positions within the Production and Stockpile Management Directorates.

As Head of Assembly and Explosives Operations at Burghfield from 2009-2012, David was responsible for providing assembly and disassembly of warheads and sub-assemblies and explosives manufacturing, to underwrite AWE's overall contract commitments.

From 2001-2009 he was the Plant Manager for AWE's enriched uranium (2001-2) and then plutonium (2002-8) manufacturing facilities responsible for the fully assured and cost effective operations of the plant and the delivery of their production program.

Prior to this he held a number of leadership roles within AWE in project, production and nuclear safety management. This has included plant and process commissioning, nuclear material management and emergency response and management.

David has a Master's degree in Chemical Engineering from the University of Cambridge (1985). He lives with his wife Diane and their two teenage sons.

David Kellock, Atomic Weapons Establishment, UK

David Kellock is the Capital Projects Programme Manager for AWE and deputy to the Director Capital Projects on the AWE Plc Board.

He took this role in September 2010 in addition to his role as Head of Front End Development at AWE and is responsible for delivering a wide range of capital projects which include:

- New build and refurbished Production capabilities
- New build and refurbished R&D capabilities
- Site infrastructure upgrades
- Security enhancements
- Future Capital Investment—"starting the rights projects properly"

David began his career at AWE as a Senior Project Manager in 2005. He has held a number of key senior leadership positions within the Capital Projects Directorate having gained early experience within the Stockpile Management Directorate.

David has a background in Process, Petrochem, Pharmaceutical and Nuclear industries in the UK and Overseas.

He lives with his wife Kim and has three sons who have completed their University education and are now following varied careers.

Sue King, Vice President, Project Operations, Shaw AREVA MOX Services, LLC

Sue King, a Chicago Bridge & Iron (CB&I) employee, was appointed Vice President of Project Operations for Shaw AREVA MOX Services, LLC in 2013. [The LLC is a joint venture between CB&I (formerly Shaw Group) and AREVA.] King is responsible for Engineering, Construction, Supply Chain Management, Project Controls, Commissioning, and Contract Management for the Mixed Oxide (MOX) Fuel Fabrication Facility Project. The organizations reporting to King currently have about 650 professionals and 400 direct construction craft. Prior to this role, King was Vice President of Operations for the MOX project, responsible for planning for the future operation of the MOX Facility, as well as overseeing physical security, material control and accountability, and fuel services across the MOX program. She joined the MOX project in 2006.

From 1997 to 2006, King served in various roles in Washington (formerly Westinghouse) Savannah River Co., including Design Authority manager and Chief Engineer for the Nuclear Non-Proliferation Program, program manager for the Pit Disassembly and Conversion Facility, acting manager of the Packaging and Transportation Group, and Fellow Technical Advisor for the Accelerator Production of Tritium project.

From 1994 to 1997, King was the Senior Scientific and Technical Advisor to the U.S. Department of Energy (DOE) manager of Pantex, a complex outside of Amarillo, Texas, that disassembles and maintains the nation's nuclear weapons stockpile. At Pantex, she assisted in the management of 90 DOE staff members and 3,300 contractors. She also was the primary interface with the Defense Nuclear Facility Safety Board.

King previously served as DOE's Deputy Assistant Manager for Nuclear Materials Processing at the Savannah River Site. In this role, she was responsible for the operation of all of the nuclear non-reactor facilities at SRS, including the startup of several key plutonium facilities.

From 1982 to 1986, King was a nuclear shift refueling engineer at the Charleston, S.C., Naval Shipyard.

King earned a bachelor's degree in chemical engineering from the Virginia Polytechnic Institute and State University (Virginia Tech) in Blacksburg, Va.

Brett R. Kniss, Los Alamos National Laboratory

Mr. Kniss is a 32 year veteran in the NNSA complex with a background in weapons manufacturing, plutonium operations and nuclear facility planning. His early career was associated with nuclear weapons manufacturing at Pantex, Kansas City and Rocky Flats as a design agency representative at the production plants during the peak years of the cold war. For the past 20 years, Mr. Kniss has been connected with the plutonium facility TA55 at Los Alamos. Initially a staff member at TA55 in the early 1990s, he progressed through roles as project leader, program manager and is currently a program director. Over the past 2 decades he has been in line management, project execution, project management and strategic planning associated with the mission planning for Defense programs, Nuclear Non-Proliferation, plutonium science and nuclear weapon certification activities. He is currently the program director for plutonium strategy in the Weapons Associate Director's office at Los Alamos and is the program architect behind the plutonium facility strategy as well as the Los Alamos representative on the Livermore red team for the annual assessment process. Mr. Kniss functions primarily as a systems engineer balancing program requirements with facility resources through the Integrated Nuclear Planning process with a wide variety of customers and stakeholders. Mr. Kniss is frequently used as a resource to assist with planning and solution development for the acquisition, sizing and cost of line item nuclear facilities supporting plutonium programs. Mr. Kniss hold a BS in Civil engineering, and a MS in mechanical engineering.

William J. Madia, Ph. D., Vice President, Stanford University and President, Madia & Associates, LLC

Dr. Madia has been a leader in research, development, and deployment of energy systems for nearly four decades. He currently serves as Chairman of the Board of Overseers and Vice President for the SLAC National Accelerator Laboratory at Stanford University. He is also President of Madia & Associates, LLC, an energy consulting firm serving the needs of government, industry, and academia. Dr. Madia retired from Battelle in 2007 as Executive Vice President for Laboratory Operations. As Executive Vice President for Laboratory Operations, his organization grew eight-fold, resulting in annual revenues of $4 billion and employing over 15,000 affiliated staff. During his career at Battelle, he held a variety of leadership positions including Laboratory Director of both the Pacific Northwest National Laboratory and the Oak Ridge National Laboratory. He was Director of Battelle's Columbus Laboratories and President of Battelle Technology International, a multi-national research organization with major laboratories in Frankfurt, Germany and Geneva, Switzerland and offices worldwide.

Dr. Madia's nuclear energy experience spans the entire nuclear fuel cycle. He created and led the first Nuclear Fuel Cycle analysis group at Battelle, managed Battelle's plutonium fuel fabrication laboratory and hot cell complex, developed proliferation resistant reprocessing flow sheets, and taught coursework in Nuclear Fuel Cycle technologies as an adjunct professor at the Ohio State University. He was a member of DOE's "Blue Ribbon Panel" on the decontamination and decommissioning of the damaged Three Mile Island reactor and provided technical support to the Chernobyl reactor stabilization and cleanup efforts. He led the national screening of geologic formations as part of DOE's High Level Nuclear Waste Disposal Program that resulted in Congress' selection of the Yucca Mountain site. At the request of Secretary of Energy Bill Richardson, he led a review of medical isotope applications for the Fast Flux Test Facility and was a member of the national Commission on Science and Security in the 21st Century. Prior to joining Battelle, he worked for General Physics Corporation, where he trained nuclear power plant operators. While serving in the U.S. Army, Dr. Madia led the Reactor Operator Qualification Phase of the Army's Nuclear Power program.

John E. Marra, Associate Laboratory Director, Science & Technology and Chief Research Officer at the Savannah River National Laboratory (SRNL), Aiken, South Carolina

John E. Marra received his B.S. in ceramic science and B.A. in chemistry from the New York State College of Ceramics at Alfred University in 1983, and Ph.D. in ceramic engineering from The Ohio State University in 1987.

Since 1987, Dr. Marra has held various technical staff and management positions at the Department of Energy's Savannah River Site (SRS). In his 25+ years at SRS and SRNL, Dr. Marra has worked in the management and treatment of high-level radioactive waste, development and application of advanced materials, and advanced chemical process applications. He has coauthored numerous publications on the application of ceramic materials in the nuclear industry.

Dr. Marra’s recent work is focused on advanced nuclear fuel cycles and long-term storage, treatment, and disposal of all forms of used nuclear fuel and radioactive waste. He currently serves as a Deputy Director in the DOE Office of Nuclear Energy (DOE-NE) Fuel Cycle Research & Development Technical Integration Office focusing on advanced chemical separations processes and waste form development.

Dr. Marra is a Past-President of The American Ceramic Society (ACerS). He is an ACerS Fellow and a past Chair and past Director of the Nuclear & Environmental Technology Division. Dr. Marra also serves on the External Advisory Board for the Department of Materials Science & Engineering at The Ohio State University.

Thom Mason, Director, Oak Ridge National Laboratory

Thomas E. Mason (B.Sc. in physics, Dalhousie University; Ph.D. in condensed matter sciences, McMaster University) is director of Oak Ridge National Laboratory (ORNL). Thom joined ORNL in 1998 as Scientific Director for the Spallation Neutron Source (SNS) project. He was named Associate Laboratory Director (ALD) for SNS and was responsible for construction and initial operation of the $1.4 B Spallation Neutron Source, which was completed ahead of schedule and under budget with technical performance exceeding the level 0 baseline requirements. He subsequently became ALD for Neutron Science with operational responsibility for SNS and the High Flux Isotope Reactor.

Before joining ORNL, Thom was a faculty member in the Department of Physics at the University of Toronto. From 1992 to 1993, he was a Senior Scientist at Risø National Laboratory. He held a Natural Sciences and Engineering Research Council of Canada (NSERC) postdoctoral fellowship at AT&T Bell Laboratories from 1990 until 1992.

Thom's research background is in the application of neutron scattering techniques to novel magnetic materials and superconductors using a variety of facilities in North America and Europe. As Director of the U.S. Department of Energy's largest science and technology laboratory he has an interest in advancing materials, neutron, nuclear, and computational science to drive innovation and technical solutions relevant to energy and global security. He is a Fellow of the AAAS, APS, and NSSA.

J. Robert "Bob" Merriman, Consultant

Dr. Merriman is a consultant in areas of uranium processing, energy, environment, and national security. His work in the nuclear fuel cycle and uranium processing fields has included roles as an individual researcher as well as in: R&D management; engineering; design and construction project management; and plant operations. He has spent most of his career in the areas of radiochemical process engineering and uranium processing and is familiar with the cross-section of uranium processing technologies, processes and equipment. He has worked on and managed the development and deployment of a variety of specialized production and separation processes associated with various steps in the nuclear fuel cycle, including fuel reprocessing, waste management, uranium processing, and isotope separation.

Bob has held a variety of technical and managerial roles in these activities. Positions held include:

- Senior Vice President, Martin Marietta Energy Systems (MMES) in Oak Ridge (ORNL, Y-12, K-25 & Central Services), Paducah, KY and Portsmouth, OH)
- Vice President, MMES (uranium enrichment facility operations, enrichment technology, applied technology, environmental programs)
- Associate Laboratory Director, ORNL
- Director, Enrichment Technology & Production
- Manager, Engineering & Technical Services (Paducah Gaseous Diffusion Plant)

Bob holds BE (Vanderbilt), MS and PhD (University of Tennessee) degrees, all in chemical engineering. He also completed the executive management program at the University of Pittsburg. His professional awards include

- The E. O. Lawrence Award (1987) Department of Energy
- The Robert E. Wilson Award (1985) Presented by the Nuclear Engineering Division of the American Institute of Chemical Engineering for work in the nuclear fuel cycle
- The University of Tennessee Outstanding Engineering Alumnus Award (1979)

Chad Monthan, Technical Manager, Active Response and Denial Department, Sandia National Laboratory

Chad Monthan is a Technical Manager with in the Weapons Security & Critical Asset Protection Programs at Sandia National Laboratories. Chad is responsible for a team of engineers that perform research, engineering development, systematic analysis, project coordination, testing & evaluation, and deployment of state-of the-art physical security systems. Hardened above/below ground facilities, power and chemical plants, secure transportation, high security vaults & doors, vehicle barrier design & testing, active denial systems (non-lethal & lethal), obscurant systems (chemical & fog), vulnerability assessments of critical facilities, scenario development, and attack tool capabilities (explosive, thermal, and mechanical) are all areas of expertise that reside within his department. In support of providing DOE, DOD, and DOS with physical security recommendations and innovative designs, Chad's team has provided blast effects and force protection analysis utilizing multiple shock-physics codes (VAPO, CONWEP, BEEM, SBEDS, CTH) in order to determine the impact of explosive threats to a given target. Through his leadership and management, this team also has developed extensive in house expertise with planning, preparation, and executing full scale and quarter scale explosive tests and simulated thermal/mechanical attacks to validate performance modeling and improve physical security designs.

Chad joined Sandia National Laboratories as a Member of the Technical Staff in the Active Response and Denial Department in 2009. He supported a number of DOE, DOD, and DOS programs with the design and deployment of physical security barriers before being promoted to Manager in 2011. As a Member of the Technical Staff he acted as a project engineer developing & deploying in-device-delay features as part of the National Nuclear Security Administration (NNSA) Global Threat Reduction Initiative (GTRI) program's efforts to mitigating the theft of radiological materials. He also leveraged his previous experience with large scale projects to help take a Sandia design that had been successfully tested and patented to the next phase of deployment further maturing its product development. This was done by creating an improved design and a plan for installation at Air Force and Navy sites.

Prior to joining Sandia National Laboratories, Chad worked as an Engineering Manager and Project Engineer for 15 years with a company that designed, built, controlled, and tested specialized engine driven pumps, compressors, and electric power generation equipment for use in government municipalities, specialized military applications, oil and gas markets, and construction industries all around the world.

Chad holds a BS degree in Mechanical Engineering from the University of New Mexico and a Master's degree in Engineering Management from New Mexico Institute of Mining and Technology.

Chad resides in Albuquerque, New Mexico. In his spare time, he enjoys spending time camping, hiking, fishing, and windsurfing with his family in the mountains of northern New Mexico and southern Colorado.

Matt Nuckols, Deputy Principal Associate Director—Capital Projects
Los Alamos National laboratory

As the Deputy Principal Associate Director for Capital Projects at Los Alamos National Laboratory, Matt is a key member of the leadership team executing both the Laboratory's portfolio of capital projects and the Laboratory's environmental programs work. The capital project portfolio includes large line item construction projects such as the Chemistry and Metallurgy Research Replacement (CMRR) project as well as small capital investments in existing facilities and infrastructure. The environmental programs portfolio includes legacy waste site cleanup, groundwater monitoring, and processing legacy hazardous and radioactive waste for shipment to permanent disposal facilities.

Prior to his current assignment, Matt was a Project Director in the Weapons Program at Los Alamos responsible for the Projects and Construction portion of the Weapons Infrastructure portfolio. In this role, Matt was responsible for program management of large, line-item construction projects such as the CMRR project, Technical Area-55 Reinvestment, and the Transuranic Waste facility, as well as program management for the ongoing Facilities and Infrastructure Recapitalization Program and future infrastructure investment activities. In addition, Matt completed a change-of-station assignment in 2009 in Washington, DC, as a senior advisor to the NNSA Assistant Deputy Administrator for Nuclear Safety & Operations. In early career assignments, Matt was a business manager and project controls engineer on projects in private sector areas such as mining and metals, telecommunications, and government services.

Cecil V. Parks, PhD, Director, Reactor and Nuclear Systems Division, Oak Ridge National Laboratory

Dr. Parks' career has spanned 35 years at Oak Ridge National Laboratory where he is now Director of the Reactor and Nuclear Systems Division (RNSD). For much of his career, he provided project and line management leadership for the development of nuclear engineering analysis software and projects that applied that software to address a broad set of nuclear technology issues related to nuclear energy, fuel cycle safety, and nuclear security (e.g., nonproliferation and safeguards). He has extensive experience in developing and implementing projects with the Nuclear Regulatory Commission (NRC), the Department of Energy (DOE), and the National Nuclear Security Administration. Since 1980, Dr. Parks has had project or line responsibility for the SCALE code system which is distributed and used worldwide for nuclear analysis. RNSD continues to modernize and expand the SCALE system, and add new software capabilities, to address challenging problems in reactor physics, criticality safety, and radiation transport. RNSD staff are also involved internationally in the measurement, evaluation, and processing of cross-section data for nuclear analysis. The Radiation Safety Information Computational Center within RNSD is a multi-program center that works nationally and internationally as a distribution center for nuclear software. More broadly, RNSD provides research and development (R&D) needed to address technology and safety issues facing the current and future utilization of nuclear reactors and the related fuel cycle system. The division is responsible for the design, fabrication, safety, and performance of irradiation experiments performed in ORNL's High Flux Isotope Reactor. The nuclear safety expertise and the computational, experiment, and technology development capabilities within RNSD are also applied to other R&D areas such as national defense, nuclear security and fusion and accelerator systems.

For over 30 years Dr. Parks has consulted with both the NRC and DOE on technical and regulatory safety issues associated with transport and storage of fissile and radioactive material. Since 1992 he has served as the US expert to the IAEA on packaging requirements and transport control for fissile material. He also represents the US at the OECD Working Party on Nuclear Criticality Safety.

Dr. Parks has a PhD in Nuclear Engineering from the University of Tennessee and MS and BS degrees in Nuclear Engineering from North Carolina State University. He also has a BS in Mechanical Engineering from North Carolina State University. He has over 150 technical publications. Dr. Parks is a Fellow of the American Nuclear Society.

Dr. Monica C. Regalbuto, Deputy Assistant Secretary for Fuel Cycle Technologies with the Department of Energy's Office of Nuclear Energy and Senior Scientist at Argonne National Laboratory

Dr. Regalbuto, a senior scientist at Argonne National Laboratory, is currently the Deputy Assistant Secretary for Fuel Cycle Technologies with the Department of Energy's Office of Nuclear Energy, whose mission promotes nuclear power as a resource capable of meeting the Nation's energy, environmental and national security needs. She manages a research and development budget of about $185 M and a federal staff workforce of about 50 employees. She previously served as a Senior Program Manager with the Office of Waste Processing with the Department of Energy's Office of Environmental Management, supporting technical risk reduction and uncertainty in the Department's clean-up programs. From 2003 to 2008, Dr. Regalbuto served as the head of the Process Chemistry and Engineering Department in Argonne's Chemical Sciences and Engineering Division and managed a group of 30 researchers. Dr. Regalbuto has been a key contributor to the development of nuclear fuel cycle technologies, where she combines her experience in separations, computer simulations and proliferation resistance.

Dr. Regalbuto has contributed to the development of innovative energy technologies throughout her professional career. She was part of the Massachusetts Institute of Technology 2010 Fuel Cycle Study Team. As a researcher at Argonne National Laboratory, she has made key contributions to nuclear fuel cycle technology, beginning with the TRUEX process for removing transuranic elements from aqueous acidic solutions such as those found at DOE waste sites throughout the United States followed by the development of advanced separations processes as alternatives for recycling spent fuel. She led the development of AMUSE, a computer model used by researchers to optimize processes for separating dissolved spent nuclear fuel. Under Dr. Regalbuto's leadership, Argonne conducted highly successful process demonstrations, the CSSX process, a process for separating cesium-137 from high-level radioactive waste at DOE's Savannah River site and the UREX+ processes, a suite of solvent extraction processes for the recovery of actinides and fission products from spent fuel.

In support of her professional growth, Dr. Regalbuto joined Amoco Oil Company in December 1996 to fulfill her desire to apply her research and development expertise in an industrial setting. As a member of Amoco's Hydroprocessing Team she provided key technical support to several refineries. Subsequently at Amoco, she was tapped to participate in a newly formed team to develop and evaluate alternative technologies for lowering the sulfur levels of gasoline. Dr. Regalbuto has authored multiple journal articles, reports, and presentations and holds six patents.

AWARDS

- 2013 U.S. Department of Energy Secretary's Achievement Award
- 2011 U.S. Department of Energy Secretary's Achievement Award
- 2010 Powerful Hispanics in Energy, Hispanic Engineer & Information Technology Magazine
- 2009 25 Outstanding Hispanic Women in Business, HispanicBusiness.com
- 2007 Professional Achievement Award, Hispanic Engineer National Achievement Award Corporation (HENAAC)

- 2007 Jane Oestmann Professional Women's Achievement Award, American Nuclear Society
- 2005 Outstanding Engineering Achievement by the Illinois Engineering Council

PROFESSIONAL MEMBERSHIPS

- American Nuclear Society
- American Institute of Chemical Engineers
- American Chemical Society
- Society of Women Engineers
- Sigma Xi Scientific Research Society

EDUCATION

- 1988 Ph. D., Ch. E., University of Notre Dame
- 1986 MS., Ch. E., University of Notre Dame
- 1983 BS., Ch. E., Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM)

Roger R. Rocha, Manager, Weapons and Complex Integration Directorate, Lawrence Livermore National Laboratory

Roger Rocha has extensive management and engineering experience at nuclear facilities. He has demonstrated proficiency in the efficient and safe implementation of regulatory directives, institutional policies and procedures, and best management practices for the operation and maintenance of complex, nuclear hazard category 2 and 3 facilities. Mr. Rocha has a B.S. in Mechanical Engineer from the California Polytechnic State University. As a manager in Lawrence Livermore National Laboratory's Weapons and Complex Integration (WCI) Directorate, he has responsibility for all aspects of nuclear and hazardous facility operations, including implementation of the management assessment program. Mr. Rocha has extensive experience assessing nuclear operations as part of his self-assessment programs, and as a member of various independent assessment teams at the Laboratory.

In January of 2013, Mr. Rocha joined the Primary Nuclear Design Program/B Division within WCI as the Operations Manager to serve as the senior advisor to division/program leadership and the point of contact for major operational issues within the division and program. As a member of the senior management team, he is responsible for establishing policies, procedures, and implementing plans to comply with directorate, laboratory, and external requirements relating to facilities, Integrated Safety and Security Management goals and objectives, and other operational practices.

Previously, June 2009 to January 2013, Mr. Rocha served as the Nuclear Materials Technology Program (NMTP) Leader, responsible for both Superblock (SBK) and Radioactive and Hazardous Waste Management (RHWM) operations. SBK operations include the overall management and strategic development of all Superblock nuclear facilities. RHWM operations include the responsibility for all aspects of Waste Management Operations pertaining to radioactive and hazardous wastes generated at LLNL and the management of Resource Conservation and Recovery Act (RCRA) permitted nuclear facilities.

From March 2005 through June 2009 Mr. Rocha served as the Building 332 Plutonium Facility Manager. In this role he was responsible for the safety, authorization basis, engineering, operations, maintenance, quality assurance, configuration management, and training in the Plutonium Facility. Additionally, Mr. Rocha was responsible for implementing a comprehensive management self-assessment program and supporting various internal and external independent assessments. In this role he frequently interacted with program managers to assure research performed in the facility is safe and complies with DOE orders and regulations, and represented the nuclear facilities to senior Laboratory management, NNSA Livermore Site Office, and the Defense Nuclear Facilities Safety Board (DNFSB). As facility manager, Mr. Rocha provided guidance and oversight to system engineers, design engineers, and other technical and administrative personnel in support of programmatic work and facility maintenance.

From July 2003 through March 2005 Mr. Rocha managed the Optics Assembly Building (OAB), which is an integral component of the National Ignition Facility and National Ignition Campaign. In this role he was responsible for the safety, quality, planning and technical execution of all activities conducted in the facility as well as oversight responsibilities for the 45 person staff.

From October 2003 through July 2003 Mr. Rocha served as the Deputy Associate Director Facility Manager (ADFM) for Chemistry & Material Science (CMS) where he was responsible for providing senior-level facility management for over 300K square feet of office and laboratory space. Responsibilities included providing daily management of all CMS facility related services, ensuring facilities are operated and maintained in a safe and efficient manner and workers comply with facility-specific requirements, preparing facility safety documentation, evaluating operational changes against the facility's existing authorization basis, leading formal self-assessments of CMS facilities, managing the Directorate's chemical tracking inventory and reconciliation, assisting in the investigation of reportable occurrences, and coordinating the CMS Self-Help Program.

Earlier assignments in Mr. Rocha's extensive engineering and management career include the following:

- Mechanical Engineering/ Defense Technologies Engineering Division (DTED) Group Leader
- Facility Operations and Maintenance Manager
- Nuclear Facility Mechanical Engineer
- Transport and Handling Operations Manager for installation of Line Replaceable Laser Units (LRUs) into the National Ignition Facility
- Sub-Critical Experiment (SCE) Engineer
- SCE Vessel Project Engineer

Joe Sandoval, Sandia National Laboratory

Joseph Sandoval is currently a Distinguished Member of Technical Staff at Sandia National Laboratories. He has worked in nuclear security since 1978 in various roles, initially as a member of a U.S. Marine Composite Adversary Team, conducting force-on-force exercises against nuclear facilities and testing tactical laser engagement system technologies and in various staff and management roles at Sandia. He worked as a Safeguards and Security manager for the Program Planning and Management, Protective Force, Physical Security, and Nuclear Material Control and Accountability departments at Sandia, responsible for the protection of over 800 facilities in a dozen locations throughout the United States, two research reactors, one million classified documents, 26,000 classified parts, and 26 metric tons of accountable nuclear material. During this time, he was responsible for overseeing the protection of a permanent Category I facility and numerous Category I tests conducted at Sandia's Tonopah Test Range in Nevada and the Coyote Test Facility in New Mexico, and was an integral part of the effort to de-inventory Sandia's New Mexico site and remove discrete Category I SNM assets. His work as an analyst has included designing, testing, and analyzing physical security systems at U.S. and international nuclear facilities. He has taught classes in physical security, vulnerability assessment methodologies, and use of vulnerability assessment simulation and modeling tools as an adjunct instructor for the Department of Energy's Central Training Academy, has worked as an instructor for NNSA's International Training Courses, and has taught several dozen physical security courses in countries of the former Soviet Union. He has participated and led numerous U.S. bilateral assessments of physical protection at nuclear facilities worldwide, and leads International Physical Protection Advisory Service (IPPAS) missions for the International Atomic Energy Agency. He is a distinguished United States Marine Corps veteran, was selected as the 4th Reconnaissance Battalion Marine of the Year five times, and served as a deep reconnaissance platoon commander during Operation Desert Shield and Desert Storm.

Alfred P. Sattelberger, Argonne National Laboratory

Al Sattelberger was educated at Rutgers College (B.A., Chemistry, 1970) and obtained a Ph.D. in Inorganic Chemistry from Indiana University in 1975. He was the recipient of a National Science Foundation Postdoctoral Fellowship at Case Western Reserve University. Prior to joining Argonne, he was a faculty member in the Chemistry Department at the University of Michigan (1977-1984) and a staff member at Los Alamos National Laboratory (1984-2006). At Los Alamos, he held several scientific leadership positions including Director of the Chemistry Division (2000-2004), and was named a Senior Laboratory Fellow in 2005. His personal research interests span early actinide chemistry, technetium chemistry and multiple metal-metal bonding. Dr. Sattelberger is the author or co-author of over 135 peer-reviewed scientific publications- many deal with actinide and fission product chemistry- and 4 U.S. patents. He is a Fellow of both the American Association for the Advancement of Science (AAAS) and the American Chemical Society (ACS), a past chair of the Inorganic Chemistry Division of the ACS, the current chair of the Chemistry Section of AAAS, and holds an adjunct faculty appointment in the Chemistry Department at Northwestern University. Dr. Sattelberger has held several senior leadership positions at Argonne National Laboratory since March, 2006. He is currently the Associate Laboratory Director for Energy Engineering and Systems Analysis (EESA). The EESA Directorate focuses on energy production, storage and use, and on national and homeland security challenges.

Dwight Squire, Lawrence Livermore National Laboratory

Engineering and Maintenance Manager with over 15 years of combined managerial and technical experience providing safe, cost-effective, and regulatory/code-compliant engineering, operations, and maintenance support of Hazard Category 2 and Hazard Category 3 non-reactor nuclear facilities. Demonstrated ability to lead multi-disciplinary teams and manage $10M+ budgets for operations, maintenance, and upgrades of the facilities physical plant, including the structure, utilities, alarms, HVAC systems, and vital safety systems.

Education

- North Carolina A&T State University; Greensboro, NC
- Mechanical Engineering, Mechanics & Materials Option; May 1992
- MSME & BSME GPA: Cumulative 3.8/4.0, Major 3.9/4.0
- Computer Skills: Fortran, Basic, C, spreadsheets, word processors, Macintosh, PC

Work Summary

Nuclear Operations Directorate (NucOps); October 2007 - Present

- NMTP Facilities Operations, Maintenance, and Engineering Manager servicing NMTP facilities, including Superblock (SBK) and Radioactive and Hazardous Waste Management (RHWM) facilities. Manages and oversees the organizations of the NMTP Facilities Engineering Manager and the NMTP Facilities Operations and Maintenance Manager. Works in close coordination with the NMTP Leader, Facility Managers, Leader for Nuclear Materials Programmatic Operations, Associate Program Leaders, Facilities and Infrastructure Directorate Defense management, and Livermore Field Office (LFO) personnel.

Technologies Engineering Division (DTED); April 1999 – September 2007

- NMTP Facilities Operations, Maintenance, and Engineering Manager servicing NMTP facilities, Buildings 239, 331, 332, 334, and 335. Managed and oversaw the organizations of the NMTP Facilities Engineering Manager and the NMTP Facilities Operations and Maintenance Manager.
- NMTP Facilities Operations and Maintenance Manager overseeing the day-to-day operation of the physical plant, equipment in the facilities and manages the Facilities Operations Group. Provided daily direction to the facilities operators and Plant Engineering Crafts personnel assigned to the facilities.
- Facility Mechanical Engineer and Project Manager for multiple facility-upgrade projects for B-332 Plutonium Facility. Provided management oversight of scope, schedule, and cost for projects assigned by Facility Engineering Manager. Oversight includes all aspects from initiation to final closeout and acceptance by the Facility Manager.
- Provided engineering support to the Facility Operations and Maintenance Manager for operation and maintenance of facility mechanical systems in accordance with the Safety Analysis Report (SAR) and Technical Safety Requirements (TSR).
- Provides guidance and direction to Plant Engineering managers, engineers, crafts, construction coordinators, and designers performing work related to facility upgrades and mechanical and fluids systems.
- Review, analyze, and approve Plant Engineering and other drawings affecting the facility and programmatic mechanical systems.
- Certified in the Human Reliability Program (HRP).
- System Engineer for high-efficiency particulate air (HEPA) filters, Increment 1 Glove Box Exhaust (GBE) ducting, and Downdraft Exhaust ducting.

- Subject Matter Expert (SME) for HEPA filters and B-332 facility Decommission and Decontamination (D&D) SME for ventilation ducting.

Applied Research Engineering Division (ARED); June 1995 - April 1999

- Project Engineer for the Mirror Fusion Test Facility (MFTF) Salvage and Demolition Project of B-431. Performed structural calculations and provided technical guidance to the LLNL Project Manager and the contractor engineer and management team to ensure the safe removal and salvage of the 30-ton magnets and associated materials.
- Lead Engineer of the Process Offgas System, Solids Feed System, and Injector Design of the Molten Salt Oxidation (MSO) Project. This project is a demonstration plant for treating mixed and hazardous waste.

Manufacturing & Materials Engineering Division (MMED); May 1992 - May 1995

- Project Leader for performing a machinability study on Aermet 100, a high strength aerospace alloy, for the Naval Air Warfare Center.
- Divided time between working on the Selene (Multi-segmented Mirror) project and doing research for fabricating precision optics.
- Performed lapping experiments using BK7 glass and cast iron as substrates and tool materials for research in the Advanced Optics Fabrication Group (AOFG). Experiments were designed and executed, data was collected and reduced, and a computer model, C code, was created to predict part wear.
- Participated in the design of an actuator and flexure support for each individual segment of the multi-segmented mirror.
- Developed spreadsheet model to evaluate the accuracy performance of a machine tool vertical slide in the Machine Tool Development (MTD) Group.
- Provided engineering support for MMED shop operations.

Summer Experience

Oak Ridge National Lab; Oak Ridge, TN

- High Temperature Heat Engine Project; Metals & Ceramics Division (1990 & 91)
- Advanced Neutron Source Project (Reactor); Thermal Science Division (1988)

Lawrence Livermore National Lab; Livermore, CA

- Elastic Emission Machining Project; Precision Engineering Program (1989)
- Salt Water Project (Smoke simulation in a room); Fire Science Division (1987)
- Student Machine Shop; Materials Fabrication Division (1986)

Awards

- U.S. Patent: Delivery System for Molten Salt Oxidation of Solid Waste
- Historically Black Colleges and Universities Nuclear Energy Training (HBCU NET)
- Program Scholarship and Fellowship
- Gerard Pierce Scholarship
- Georgia Pacific Scholarship
- National Deans List
- Academic All-American

Organizations

- The Tau Beta Pi Association
- Pi Tau Sigma Honor Fraternity

Jimmy Stone, Director, Facility and Operations Directorate, Oak Ridge National Laboratory

Jimmy Stone is Director of the Facilities and Operations Directorate at the Oak Ridge National Laboratory in Oak Ridge, Tennessee. In this position, he manages seven divisions that provide critical laboratory support services. These include facility operations, laboratory protection (security, fire protection, emergency preparedness, and emergency management), engineering and construction management, materials fabrication, site services, logistical functions, and craft services. In addition, the Facilities and Operations Directorate includes facilities strategic planning and natural resources functions.

Jimmy's accomplishments at ORNL include being part of the management team that revitalized and modernized the campus, helping to create the Department of Energy's largest science and energy laboratory. He also implemented a "landlord-tenant" model for operating facilities and has been responsible for achieving significant gains in efficiency, customer satisfaction, and, most notably, safety.

Prior to joining ORNL, Jimmy worked at Y-12 for 16 years, which included five years as the Director of Enriched Uranium Operations (EUO). EUO includes Buildings 9212, 9215, and 9206.

Jimmy has more than 26 years of experience in engineering, project management, nuclear operations, and facilities operations.

He earned a Bachelor of Science degree from Tennessee Technology University and a Master's degree from the University of Tennessee.

Jimmy is an avid golfer and runner. He and his wife, Laurie, live in Knoxville, Tennessee, and have two children, Haley and Heath.

Derek Wapman, Lawrence Livermore National Laboratory

Mr. Derek Wapman joined Lawrence Livermore National Laboratory (LLNL) in 1980 and has extensive experience in nuclear weapon engineering and project management. He has had technical involvement with many weapon systems, including the W79, W80, W82, W87, B83, and Reliable Replacement Warhead (RRW). He has been the system manager for the W80, the project engineer for the W79 enablement and dismantlement systems, W87 Life Extension Program (LEP), W80 LEP, and numerous other weapons-related projects.

Currently, he is the Program Director for Nuclear Weapon Engineering in the Weapons and Complex Integration (WCI) Program Directorate and the Division Leader for the Defense Technologies Engineering Division.

He holds a B.S. from Oregon State University and an M.S. from Stanford University in mechanical engineering.

Ray Wymer, Consultant

Dr. Raymond G. Wymer received his B.S. degree from Memphis State University, and his M.S. and Ph.D. degrees in chemistry and physics from Vanderbilt University. Dr. Wymer was employed by Oak Ridge National Laboratory in the Chemical Technology Division from 1953 until his retirement in 1991. During his employment at ORNL he was involved in research and development in all aspects of the nuclear fuel cycle. He became Director of the Chemical Technology Division, a chemical engineering division employing about 300 chemical engineers, chemists, technicians and support staff.

Dr. Wymer has consulted extensively since his retirement in 1991 in the areas of radioactive waste management, fuel cycle process chemistry, and site remediation for DOE and its contractors. He has had extensive consulting experience at Hanford with the Tank Waste Remediation Systems program. He assists DOE and its contractors in program reviews. Dr. Wymer has served on numerous committees and workshops of the National Academies (formerly the National Academy of Science) that deal with DOE's waste management and site remediation activities and closure activities. He is an Associate Member of the National Academies. He is currently a member of the National Academies' Nuclear and Radiation Studies Board.

Dr. Wymer is an Adjunct Professor in the Department of Civil and Environmental Engineering at Vanderbilt University.

Dr. Wymer's other activities include consulting with DOE, the U.S. Department of State, the National Nuclear Security Agency and the International Atomic Energy Agency on matters of nuclear non-proliferation in the areas of nuclear fuel reprocessing, uranium refineries, uranium conversion and uranium enrichment by chemical exchange processes. He served on a United Nations UNSCOM team to Iraq in the mid-1990s evaluating Iraq's uranium enrichment capability by chemical exchange. He is currently a consultant for Oak Ridge National Laboratory.

Dr. Wymer is co-author of a book "Chemistry in Nuclear Technology" and co-edited a book on "Light Water Reactor Fuel Reprocessing." He was an editor of the journal Radiochimica Acta for more than ten years until his retirement. He has written numerous reports and open literature publications and made presentations on all aspects of the nuclear fuel cycle and has contributed technical articles for incorporation in encyclopedias.

Dr. Wymer has received recognitions for his contributions in the nuclear area, including the Robert E. Wilson Award in Nuclear Chemical Engineering from the American Institute of Chemical Engineers and the Glenn T. Seaborg Actinide Separations Award.

Appendix C. List of Supplementary Interviews

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Red Team Visit to the Y-12 National Security Complex March 10-21, 2014

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Monday, March 10

Time	Event	Participants	Description
7 a.m.	Arrive at Y-12 New Hope Center (NHC) For Badging (PINS and BIO's) and TLD's	Al Sattelberger Mike Goff Matt Nuckols Brett Kniss Roger Rocha Derek Wapman Thom Mason Jimmy Stone Cecil Parks Chad Monthan John Marra David Kellock David Jones Tim Driscoll Loring Wyllie Ray Wymer Susan Howell Sue King Calvin Hopper Bob Merriman Connie Hall Steve Howell Joe Sandoval	

7:45 a.m.	Depart NHC for Jack Case Center, N3.C05 VIP Buses	All	TBD to vouch group through Post 13
8 a .m.	Arrive at the JCC, N3.C05 for Briefings Introduction/Welcome/Purpose • Administration – Mona Glass • B&W Y-12 – Dave Richardson • NPO - Ken Ivey • UPO – John Eschenberg • Purpose – Thom Mason	Visitors John Eschenberg, NNSA Dave Richardson, B&W Van Mauney, B&W Linda Bauer, B&W Carl Strock, B&W Mike Pratt, B&W Tony Giordano, B&W Bill Heineken, B&W Rod Johnson, B&W David Wall, NNSA Ken Ivey or Teresa Robbins, NNSA Dale Christenson, NNSA John Gertsen, B&W Mona Glass, B&W Brenda Hunter, B&W Lisa Loden, ORNL Joe Birdwell, ORNL Bill Strunk, ORNL Larry Avens, ORNL John O'Neil, ORNL John Kreykes, ORNL	
9:00 a.m.	Classification Overview – Led by Scott Hope • Classified • Unclassified Controlled Nuclear Information (UCNI)	All	
9:30 a.m.	PU Strategy • Briefing by LANL Brett Kniss • Discussion of Similarities and Differences Between EU and PU Strategy John Gertsen	All	
10:45 a.m.	Briefings: Y-12 and 9212 Orientation • Y-12 Overview J. Gertsen (15 min)	All	
11:15 a.m.	Lunch – 3rd floor Lobby	All	

12 p.m.	Briefings: Y-12 and 9212 Orientation Continued • UPF Missions and Historical Alternatives John Gertsen (15 min) • UPF Scope, Design Maturity and Project Status Carl Strock (30 min) • Y-12 Enriched Uranium Process J. Gertsen (120 min)	All	
2:45 p.m.	Break	All	
3:00 p.m.	9212 Transition Plan – Led by Mona Glass (60 min)	All	
4:00 p.m.	Daily wrap up and Actions Review of tour requirements	All	
4:30 p.m.	Depart Y-12 for NHC VIP Bus	Visitors	
Tuesday, March 11			
7 a.m.	Arrive at NHC for Expedited Entry into the PA and MAA Security Scan in Lobby of NHC	Visitors Lisa Loden, ORNL Joe Birdwell, ORNL Bill Strunk, ORNL Larry Avens, ORNL John O'Neil, ORNL John Gertsen, B&W Mona Glass, B&W Tony Giordano, B&W Ken Ivey or Teresa Robbins, NNSA Bron Johnston, B&W	VIP Bus
7:30 a.m.	Depart NHC for Bldg. 9212 and 9215/9720-82	All (E-Wing and basement, special processing upstairs, B-1 wing, OCF) (M-wing and basement, H2)	Divide into 2 groups – 9212 and 9215/9720-82 (separate buses)
7:45 a.m.	Arrive at 9212 for Tours Led by Kathy Martin, Andy Huff, Joey Lloyd	All	Inside facilities will divide into 2 groups
7:45 a.m.	Arrive at 9215 for Tour		

8:45 a.m.	Arrive at 9720-82 for Tour Led by Julie Huff and Byron Hawkins	All	Will divide into 2 groups in facility
9:45 a.m.	Groups will switch and 9212 will go to 9215	All	
9:45 a.m.	Groups in 9720-82 will depart for 9212	All	Inside facility will divide into 2 groups
10:45 a.m.	Group in 9215 will go to 9720-82	All	
12:15 p.m.	Depart the PA for the JCC	All	Both buses
12:30 p.m.	Arrive at JCC, N3.C05 for Lunch	All	Lunch in 3rd Floor North Lobby
1:30 p.m.	Uranium Infrastructure Strategy at Y-12 John Gertsen (60 min)	All	
2:45 p.m.	Break	All	
3:15 p.m.	UPF Alternatives Study Tony Giordano (120 min)	All	
4:30 p.m.	Daily wrap up and Actions	All	
5 p.m.	Visitors Depart the JCC for the NHC	Visitors	VIP Bus
Wednesday, March 12			
7 a.m.	Arrive at NHC for Expedited Entry into the PA and MAA	Visitors Tony Giordano Lisa Loden, ORNL Joe Birdwell, ORNL Bill Strunk, ORNL Larry Avens, ORNL John O'Neil, ORNL John Gertsen, B&W Mona Glass, B&W Ken Ivey or Teresa Robbins	VIP Bus
7:15 a. m.	Depart the NHC for the PA, Building 9204-2E	All	
7:30 a.m.	Arrive at 9204-2E for Tour – Led by J. Hagemann, B. Johnston and Jim Hackworth	Visitors Others TBD (dismantlement, assembly, QE, first floor)	Divide into 3 groups (each group will stay with their tour lead)

9 a.m.	Depart 9204-2E for the JCC	All	
9:15 a.m.	Arrive at the JCC, N3.C05 for Briefings and Discussions	All	
9:30 a.m.	AWE brief D. Jones (30 min)	Visitors Mike Pratt Carl Strock	
10 a.m.	Discussion: Technology Review (105 min) • DER/ER J. Leckey/J. Gertsen • UPF Baseline Technologies G. DeVault	All Ken Keith Mike Pratt	
11:30 a.m.	Break for Lunch	All	
12:15 p.m.	Resume Discussion: Technology Review	All	
12:30 p.m.	Discussion: Mission Requirements continued • Production Requirements T. Fisher and S. Sanders (30 min) • Metal Supply S. Laggis or T. Knight (30 min) • PRD/SRD T. Insalaco/B. Zulliger (30 min) • PRD vs. P&PD J. Gertsen (15 min) • Q/A panel (30 min)	All Van Mauney Mike Pratt Bron Johnston	
3 p.m.	Break	All	
3:15 p.m.	Team Discussion	All	
4:30 p.m.	Daily wrap up and Actions	All	
5 p.m.	Visitors Depart JCC for the NHC	All	VIP Bus

Thursday, March 13			
7:30 a.m.	Arrive at the NHC for Transportation to Jack Case Center	Visitors	VIP Bus
7:45 am.	Arrive at N3.C05 for Discussions	Visitors	
8:00 a.m.	Discussion: Uranium Disposition and Policy Issues – Moderated by M. Glass (120 min) • EU inventory policy • EDL • WACs • Accountability • Shipping	All Panel to include: B. Eddy, T. Knight (or S. Laggis), A. Wilson, K. Kimball, G. Person, M. Hassler and E. Sampsel In attendance - Dale Dunsworth, Van Mauney, Mike Pratt, Glenn Pfenningwerth, Blake Scott	
10:00 a.m.	Break	All	
10:15 p.m.	Discussion: Overarching Issues Moderated by M. Glass (120 min) • Nuclear Safety • Criticality Safety • Security • NMC&A • Seismic and Fire Protection	All Panel to include: A. Wilson, K. Kimball, D. Beard/J. Knott, K. Keith, J. Hunt In attendance – Mike Pratt	
12:15 p.m.	Break and Board Buses for ORNL	All	ORNL Buses
12:40 p.m.	Lunch	All	
1:30 p.m.	Framing Discussion: Led by C. Parks/J. Gertsen Building 5300	All Mike Pratt Ken Keith	
4:15 p.m.	Daily wrap up and Actions		
5 p.m.	Visitors Depart ORNL for Dinner	All	ORNL Bus
5:30 p.m.	Dinner – The Cabin	All	

7 p.m.	Depart for Y-12 New Hope Center	Visitors	ORNL Bus
Friday, March 14			
7:30 a.m.	Visitors Arrive at New Hope Center for Transportation to ORNL	All (may need to adjust this as folks going to airport may want to drive to ORNL directly and bypass NHC)	VIP Bus
8 a.m.	Q&A and follow up actions gathered from week	All	
9:30 a.m.	Recommendations – TBD	All	
11:30 a.m.	Lunch	All	
12:30 p.m.	Team Meeting	All	
2 p.m.	Visitors Depart ORNL for the NHC	All	

Second Week based out of ORNL and will include briefing of CAPE Review

Additional Interviews and Presentations

Meetings with Dexter Beard and Jeff Knott to discuss the Y-12 Perimeter Intrusion Detection and Assessment System (PIDAS) and cost drivers

Meetings with John Gertsen on strategic considerations

Meetings with K. Martin and J. Thomas on 9212

Meetings with Y-12 experts on electro-refining, direct electrolytic reduction, calciner, microwave, and saltless direct uranium oxide reduction (SDOR) for a technology review

Meetings with John Eschenberg on strategic considerations

Meetings with J. Lloyd and T. Northcutt on 9215

Meetings with Joe Hunt on seismic issues

Meetings with Erhart on strategic considerations

Meetings with Amy Wilson on Nuclear Materials Control and Accountability (NMC&A)

Meetings with Jim Haynes and Carl Strock on strategic considerations

Meetings with Bobby Oliver, Kevin Kimball, and representatives of Y-12 Fire Protection on safety issues and regulatory drivers

Meetings with J. Hackworth and m. Letsinger on 9204-2E

Meetings with Dave Richardson on strategic considerations

Meetings with Johnafred Thomas, Rebecca Boser, David Wease, and Jeff Barroso on 9212 Facility

Management Meetings with Tony Giordano on Uranium Processing Facility UPF cost information

Meetings with Mark Braccia and Steve Cruz, both UPF engineers, to discuss structural design requirements and process space requirements

Meetings with Rodney Patton and process engineers to review process design activities

Meeting with John Gertsen, Eric Sampsel, and Mike Malone to discuss various aspects of Chemical Recovery and SOX operations as planned for UPF.

CAPE Presentation by Steve Miller and Curt Khol, "Combined Plutonium Strategy & UPF Assessment"

Appendix D. Funding Approach:
A Different Approach to Funding EU Capability Replacement

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Funding Approach:
A Different Approach to Funding EU Capability Replacement

The nation's enriched uranium (EU) enterprise at the Y-12 National Security Complex (Y-12) is in need of recapitalization. The current approach is to recapitalize the majority of the enriched uranium processes in one large building, the Uranium Processing Facility (UPF). As the UPF project is deferred, the need to invest in the existing infrastructure increases. Achieving balance between investments in new replacement facilities and current aging facilities is challenging under the current distinct funding mechanisms of capital investment projects, operating (program) funds, and infrastructure funds.

Figure D-1 depicts how the EU investment funding is currently structured as a function of time. The funding is dominated by the UPF project; other smaller investments of program and infrastructure funds are provided to help reduce the ongoing risks in both existing facilities and processes. Unfortunately the increasing cost burden and delayed schedule for the new UPF necessitates more risk reduction investments in the near term to sustain the current missions.

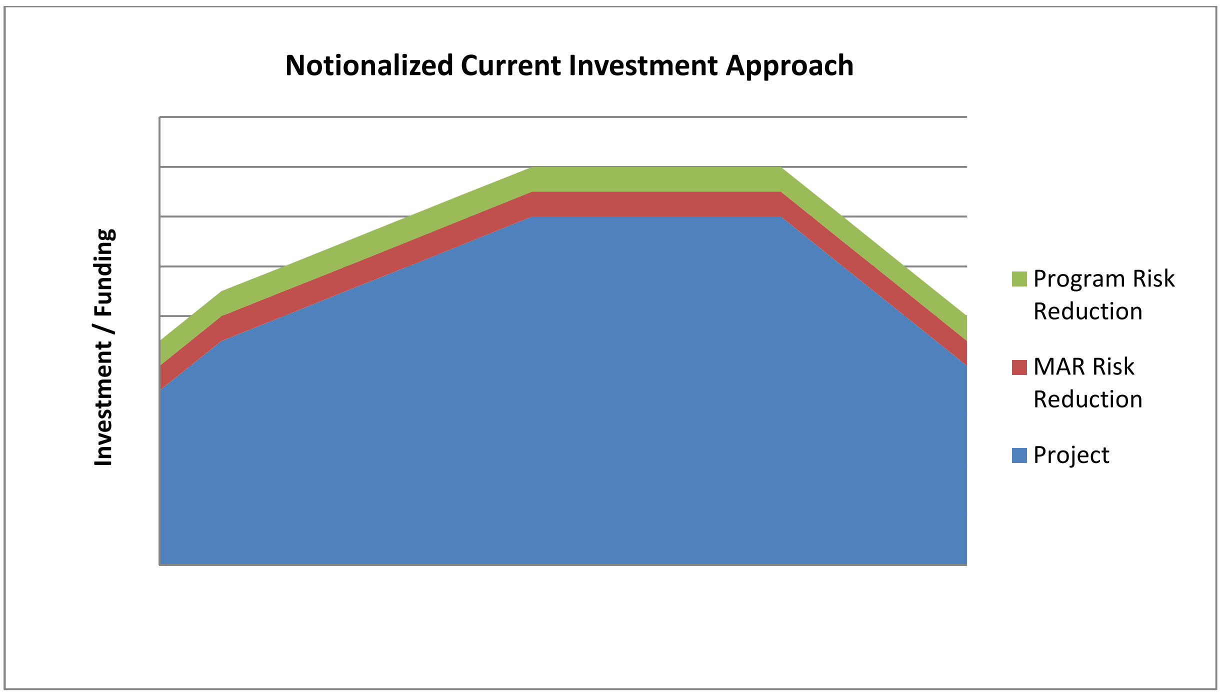

Figure D-1. Current EU investment funding over time.

A different approach provides for a substantial change in the UPF line item project. Instead of a capital acquisition for the design and construction of a "big box" facility to replace all the capabilities, one could imagine a seamless movement of resources between risk-reduction activities, repurposing old facilities, and constructing smaller new facilities.

The proposed approach should provide a consistent annual funding profile for EU investment strategies, which could be balanced between the delivery of replacement facilities and the reduction of risk in the ongoing operations. This improved plan and approach is depicted in Figure D-2. The premise of a single career executive who would have the authority and responsibility to balance the funding stream investments across the EU enterprise enables this alternative EU strategy. The bands of funding which the executive would balance consist of the same categories as before, but could be expanded to allow optimization of the funding to target specific opportunities. The category expansions include

- Program Risk Reduction—A combination of infrastructure resilience and technology and process development;
- MAR Risk Reduction—Material consolidation, reprocessing, repackaging, and/or movement from targeted facilities to reduce safety risk; and
- New Project—Design and construction of replacement facilities by process.

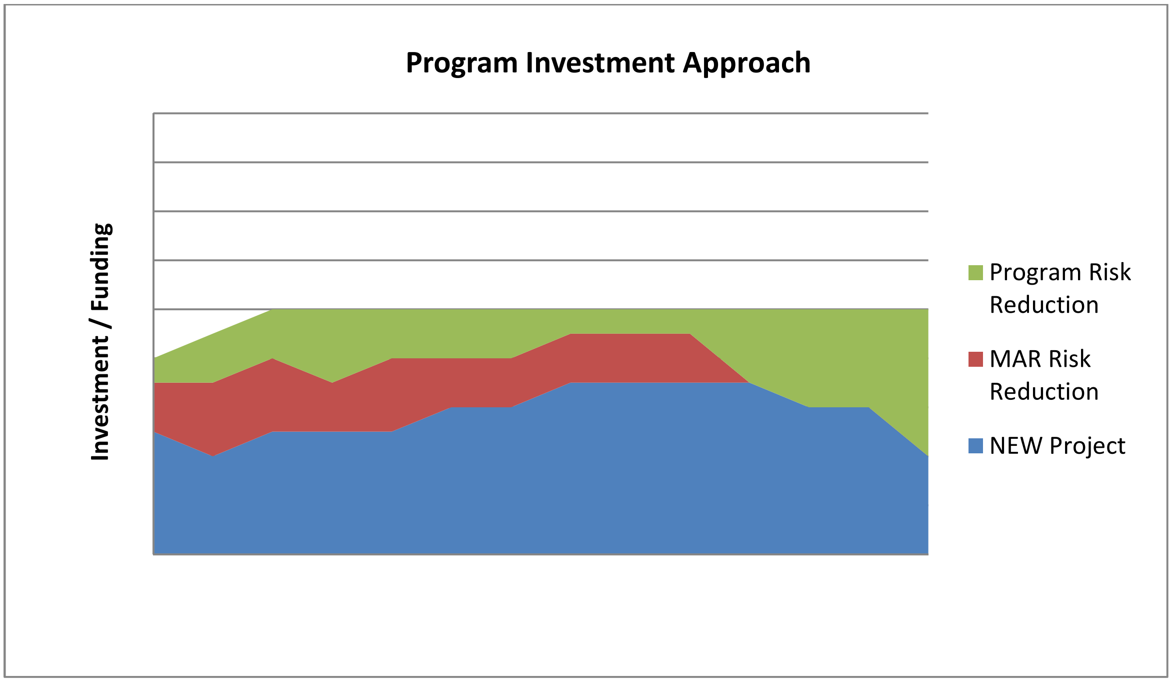

Figure D-2. Funding plan for EU replacement strategies over time.

Rebalancing the operational needs at Y-12 and the new build of a replacement facility provide a sustainable approach to mission success and a reduction in safety and mission risks.

Appendix E. Assessment of Facility and Process Sustainability and Risk Reduction in Buildings 9204-2E and 9215

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Assessment of Facility and Process Sustainability and Risk Reduction in Buildings 9204-2E and 9215

9215

Both the Facility Risk Review Follow-on Evaluation (FRR II) and the 9215 Operations Plan (Ops Plan) for Sustainment Activities have identified activities, upgrades, and maintenance investments required to sustain the facility. They were based on the following key factors, requirements, and assumptions:

- FRR II assumes that the facility will be required to operate through 2030.
- The Ops Plan identifies primarily “near-term” investments through 2015, although the current plan recognizes that enriched uranium machining operations are likely to continue in 9215 until 2038.
- Both the FRR and the FRR II identified major performance category 2(PC-2) natural phenomena upgrades that are not planned because the significant impact to production, line-item projects, and costs for these upgrades was judged to provide relatively small overall risk benefits. In addition, the upgrades would still not meet PC-3 requirements.
- A similar logic for natural phenomena upgrades was applied to upgrades to meet the intent of Confinement Ventilation.
- Materials at Risk (MAR) is not considered a risk factor in the FRR II assessment.

FRR II Investments

Table E-1 summarizes the high-priority critical sustainment investments identified by the FRR II, in priority order.

Table E-1. Critical sustainment investments identified by FRR II		
Priority	**Investment**	**Estimate ($K)**
1	Safety system sprinkler head replacement	4500
2	Increased maintenance resource capacity	15000
3	Critical spares	3500
4	Motor control center replacements	2000
5	Mop water system (crit safety issue)	1000
6	Air handling unit upgrades	1500
7	Stack 4 upgrades	6000
8	Lighting panels	8500
9	Power panel	150
10	Machining capability (four lathes)	10000

9215 Operations Plan Investments

The graphs in Figure E-1 [taken from the 9215 Operations Plan for Sustainment Activities (9215 Ops Plan)] demonstrate the assessed risk in the facility by system as well as the sustainment cost estimate by fiscal year. With respect to the sustainment cost by fiscal year, the blue bar represents the base facility operating budget. These charts do not address process equipment risks and corresponding sustainment investments.

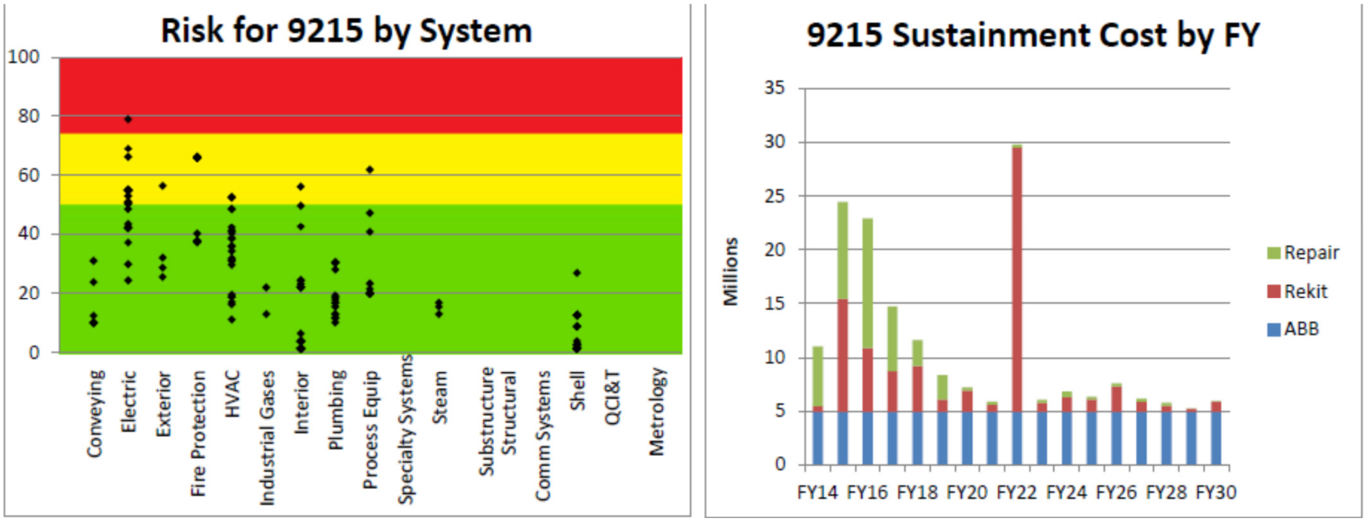

Figure E-1. Assessed risk and sustainment cost by fiscal year for 9215.

According to the 9215 Ops Plan, the highest areas of vulnerability for the 9215 Complex are in the heating, ventilation, and air-conditioning (HVAC); electrical; and interiors systems. Specifically, for the interiors, the highest vulnerability relates to the 9215 M-Wing plenum. In 2012, a portion of the steam and/or condensate piping in the plenum failed, and water leaked into the production areas below. The plenum is an asbestos-contaminated and a radiologically contaminated area (as well as a confined space) that requires significant Industrial Hygiene and radiation protection controls in order to enter. There is also a risk that, upon entry, the asbestos that is contained in the plenum will migrate to the processes. Given that there are numerous utilities in the plenum that will at some time require maintenance or repair, the risk of asbestos contamination on the production floor is ongoing and increasing.

A summary of the highest priority facility sustainment investments, in priority order, is listed in Table E-2. The team utilized the information provided in the 9215 Operations Plan (as well as reference to the FRR II) to define the priority levels.

Table E-2. Critical facility investments identified in the 9215 Operations Plan

Priority	Investment	Estimate ($K)
1	M-Wing plenum repairs and asbestos abatement	None provided
2	Update 9998 electrical one-line drawings	400
3	Aged sprinkler replacement	1750
4	Lighting upgrades in M-Wing, H2 Wing and O Wing	4500
5	Replace utility sets, belts, etc., on supply fans	600

A summary of the highest sustainment investments for 9215 production processes/ equipment, as assessed in the 9215 Ops Plan, is listed in Table E-3. The team utilized the information provided in the 9215 Ops Plan (as well as reference to the FRR II) to define the priority levels.

Table E-3. Critical process equipment investments identified in the 9215 Operations Plan		
Priority	Investment	Estimate ($K)
1	Mop water (crit safety issue)	1000
2	Stack 4 environmental and safety issues	6000*
3	Process exhaust improvements (engineering analyses, spare parts, PM's and remote transducers)	150
3	Backup band saw (to address single point failure concern)	200
4	Upgrade obsolete controllers for LeBlond and Excello machine tools	None provided
5	Procure additional lathes and saws	10000*
*Estimate taken from FRR II.		

9204-2E

Both the FRR II and the 9204-2E Operations Plan for Sustainment Activities (9204-2E Ops Plan) have identified activities, upgrades, and maintenance investments required to sustain the facility. They were based on the following factors, requirements, and assumptions:

- FRR II assumes that the facility will be required to operate through 2030.
- The 9204-2E Ops Plan recognizes that 9204-2E production operations are likely to continue until 2038 and have developed a sustainment strategy accordingly.
- In both the FRR and the FRR II, upgrades to meet the intent of Confinement Ventilation are not planned because of the significant impact to production, cost, and time to implement. In addition, the upgrades would not provide a corresponding improvement in operational reliability and safety.
- MAR is not considered a risk factor in the FRR II assessment.

FRR II Investments

Table E-4 shows the high-priority critical sustainment investments identified by the FRR II, in priority order.

Table E-4. Critical sustainment investments identified by FRR II		
Priority	Investment	Estimate ($K)
1	Safety system sprinkler head replacement	2500
2	Motor control center replacement	3000
3	Replace/refurbish lighting panels	1200
4	Increased maintenance resource capacity	15000
5	Critical spares	3500
6	Switchgear replacement	7000
7	Motor control center replacements	1000
8	Switchgear replacement	14000
9	Process environment air handling unit upgrades	2500
10	Kathabar ductwork replacement	750

9204-2E Operations Plan Investments

The graphs in Figure E-2 (taken from the 9204-2E Ops Plan) demonstrate the assessed risk in the facility by system as well as the sustainment cost estimate by fiscal year. With respect to the sustainment cost by fiscal year, the blue bar represents the base facility operating budget. NOTE: these charts do not address process equipment risks and corresponding sustainment investments.

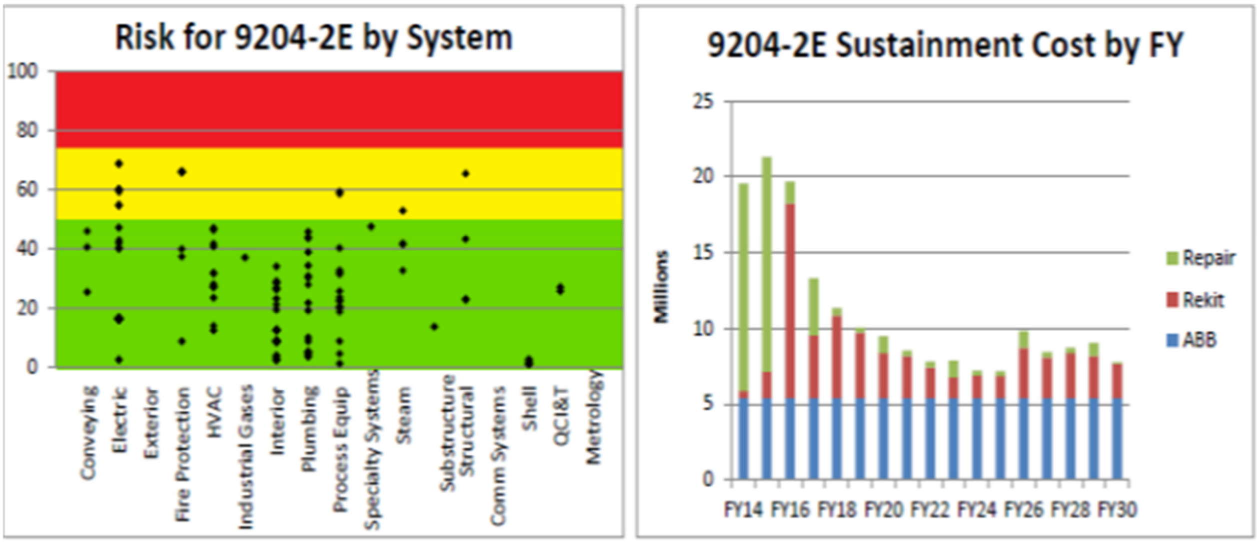

Figure E-2. Assessed risk and sustainment cost by fiscal year for 9204-2E.

According to the 9204-2E Ops Plan, the highest areas of vulnerability for 9204-2E are in the electrical, HVAC, and structural systems. A summary of the highest priority facility sustainment investments is listed in Table E-5. The team utilized the information provided in the 9204-2E Ops Plan (as well as reference to the FRR II) to define the priority levels.

Table E-5. Critical facility investments identified by 9204-2E Operations Plan

Priority	Investment	Estimate ($K)
1	Switchgear replacement	12000
2	Replace/refurbish Motor Control Centers	4000
3	Aged sprinkler replacement	1050
4	Replace power panels	1200
5	Lighting upgrades	5500

According to the 9204-2E Ops Plan, there are six pieces of production equipment considered to be high risk to sustain mission capability. These include the multimass leak detector, backfill and crimp station, environmental room ventilation system, electron beam welder, multiaxis orbital machining center, and laser gas sampling. A summary of the highest sustainment investments for production processes/equipment is listed in Table E-6. The team utilized the information provided in the 9204-2E Ops Plan (as well as reference to the FRR II) to define the priority levels.

Table E-6. Critical process equipment investments identified by the 9204-2E Operations Plan		
Priority	**Investment**	**Estimate ($K)**
1	Upgrade environmental room controls	2500
2	Develop redundant backfill crimp capability	2000
3	Critical spares for A and B level equipment	3750
3	Replace obsolete air purifier	2500
4	Spare parts for other equipment	200

Based on information in the FRR II and Ops Plan for each facility, as well as interviews with facility and production managers and tours of the facilities, the team considers the current status of 9215 to be at higher risk in terms of facility and production process sustainability.

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(U) Appendix F. Preliminary Evaluation of the Safety Hazard Category and Security Category of Unit Operations Relocating from 9212
(not included in this document)

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Appendix G. Evaluation of Preparing Pure Uranium Oxide for Storage or Feed to an Oxide Reduction to Metal Process

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Evaluation of Preparing Pure Uranium Oxide for Storage or Feed to an Oxide Reduction to Metal Process

Highly enriched uranium in a variety of chemical and physical forms and enrichments will be received and must be treated in the new uranium processing facilities. Most of the uranium is in the form of metal that can best be handled by electro-refining (ER), an electrolytic fused-salt process that can accept many configurations of uranium metal as input and produce solid, reproducible uranium dendrites as output. However, in addition to ER there exists a need for a limited-capacity, versatile processing capability to purify uranium not suited to treatment by ER, both to produce oxide suitable for reduction to metal (high-equity uranium) and for storage as oxide (low-equity material). The process must be able to accept a large range in compositions, configurations, and purities of the input uranium and to produce a highly purified uranium oxide product. Aqueous processing and associated downstream processes have the demonstrated capability to meet the requirements for versatility and purity of oxide product and are well suited to handle variable throughput requirements.

Table G-1 contains a summary of how various feed streams are proposed to be handled in the current “Issued for Design” process flow diagrams and revisions that reflect incorporation of ER and a new multipurpose system [modified special oxide production (SOX)].

Table G-1. Summary of feed streams and revisions

System	Major feed streams, current flowsheets	Major feed streams, with ER and modified SOX
SOX		**Comments**
	HE U_3O_8 from metalworking	Skull oxide less with microwave
	Oxides from bulk metal oxidation	Most to ER as metal
	Off-spec oxides from packaging	Recommend processing in modified SOX
	Alloys	
PEX		**Eliminate System, disposition feeds as noted**
	Concentrated nitrate solution from REX	Recommend processing in modified SOX
	Various oxide sources as noted below, but if aqueous processing needed:	Aqueous processing requirements less if DER deployed
	Dissolved oxides from recovery furnaces (Chemical Recovery)	Recommend processing in modified SOX
	Leached passivated materials from SDOR processing	Recommend processing in modified SOX if SDOR adopted.
	Miscellaneous dissolved oxides from HEUMF, other sources	Recommend processing in modified SOX
	Dissolved oxides from casting	Recommend processing in modified SOX
REX		**Eliminate System, disposition feeds as noted**
	Off-spec condensate and/or product from REX evaporators	Eliminated with elimination of REX but equivalent streams are likely from a replacement evaporation process
	PEX raffinate	Recommend processing in modified SOX
	Off-spec REX raffinate	Eliminated with elimination of REX
	Uranium-containing spills	Recommend processing in modified SOX
	“Centrate” (supernatant) from precipitation operations	Recommend processing in modified SOX
	Leachates from beaker leaching	Recommend processing in modified SOX
	Dissolved $Ca(NO_3)_2$ from SDOR	Eliminated by DER deployment Can be used in modified SOX to boost U extraction

Conclusion

As indicated above, there will be a continued need for some aqueous processing. However, it appears that many streams previously earmarked for purification via aqueous processing at multiple locations can now either be processed in a new multipurpose system or be directed to ER. Providing this versatile, relatively small processing system, composed of a dissolver, centrifugal contactor cascade, evaporator, calciner, and hydrogen reduction furnace, is prudent to provide the versatility the new facilities will need to manage the variety of inputs received. It is suggested that an anion exchange be evaluated as a way to recover tramp uranium from SOX raffinate, reflecting the elimination of the REX system which normally serves this purpose. Given the requirement for SOX processing capability, The Review Team recommends expanding the functionality of the SOX purification line somewhat to provide capability for the additional streams and also contingency/backup for ER. The suggested conceptual flowsheet is shown in Figure G-1.

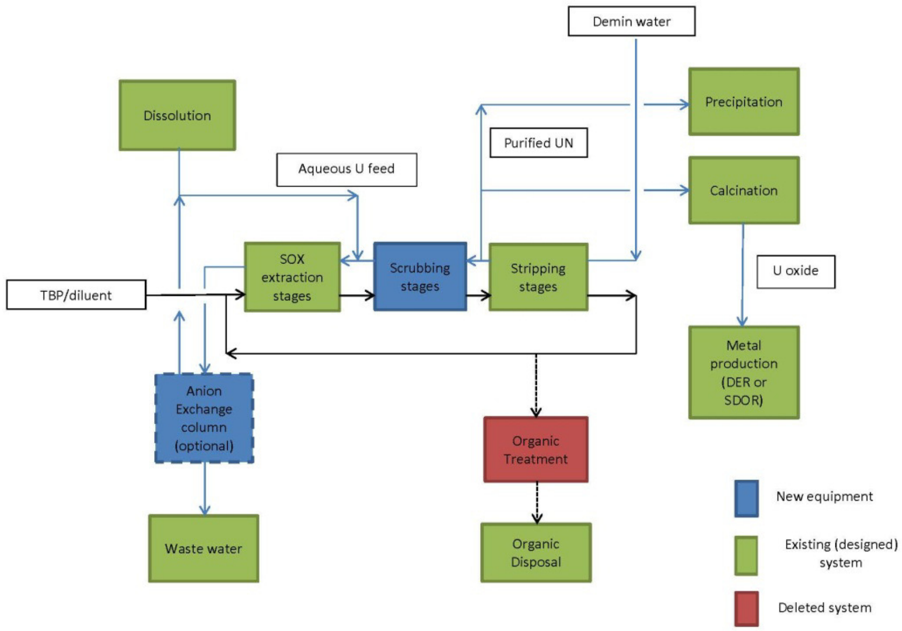

Figure G-1. The existing uranium enrichment system and proposed additions and deletions.

This multipurpose system would be operated in a campaign mode. The system should be designed along the lines of the current primary extraction (PEX) process with regard to purification capability but should balance purification against residual uranium concentration in the raffinate stream to reduce rework. While somewhat conflicting, a reasonable balance is achievable. Clean-outs between campaigns would of course be required. Further, it is recommended that "just-in-time" material management be evaluated to determine if the process hardware might be located in a lower hazard class facility.

Full advantage should be taken of the lower throughputs for some streams and the use of low hold-up/low inventory purification processes in the new facilities. Further, it is recommended that processing logistics and "just-in-time" material management be evaluated to determine if the process hardware might be located in a lower hazard nuclear facility. It is recognized that this is a significant challenge but the potential benefits are also significant.

Elimination of recovery extraction (REX) and PEX effectively cuts the organic solvent inventory by two-thirds. Under the conditions present in SOX extraction, solvent degradation will occur at a very low rate. Consequently, it is recommended that solvent be disposed of, allowing elimination of the organic treatment operation in chemical recovery.

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Appendix H. Requirements Impacting Costs

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Requirements Impacting Costs

The Review Team (RT) reviewed interpretations and applications of topical regulatory design requirements that have impacted the current Uranium Processing Facility (UPF) critical design process (CD-1) regarding design and construction costs. Topical areas reviewed included

- Nuclear Criticality Safety (NCS),
- Seismic Design (SD),
- Chemical Safety (CS),
- Natural Phenomena Hazards (NPH),
- Fire Protection (FP),
- Industrial Safety (IS),
- Radiation Protection (RP), and
- Safeguards and Security (SS).

Although SS, RP, and IS adversely affect the estimated construction cost of the UPF single structure ("big box") facility, it is judged that those effects are not as subject to interpretation as other areas and are not nearly as significant as the requirements for NCS, SD, NPH, CS, and FP. These latter requirements can be large cost drivers, especially as integrated and compounded by the hierarchy of safety concerns for specific operational conditions, equipment, and processes. Further compounding cost decisions are the various review "authorities" related to the final approval of safety designs, including

- The current design contractor for the UPF (B&W Technical Services Y-12, LLC)
- The US Department of Energy (DOE):
  - UPF Project Office (UPO),
  - NNSA Production Office (NPO),
  - Chief of Defense Nuclear Safety,
  - Office of Health, Safety and Security (HSS),
  - Chief Operating Officers, and
  - Under Secretary for Management and Performance (recently);2 and
- The US Defense Nuclear Facility Safety Board (DNFSB).

Each of the above review, comment, and revision processes complicates the influences, interpretations, understandings and implementations of the requirements and guidance that have an impact on costs and risk-to-benefit-ratios. The number of such influential processes makes it difficult to implement a graded approach with a clearly defined "risk-informed" perspective. Before and during the Review Team assessment, the Y-12 National Security Complex safety authorization basis staff was asked to provide a tabulated accounting of the interpreted and applied categorical requirements as they influenced the cost/benefits to the single facility UPF design and eventual construction. Additionally, the staff was asked to provide suggestions for alternative regulatory interpretations and applications, or exemptions, that would reduce design costs while maintaining acceptable protection of workers, co-workers, and the public. The staff

[2] 12 February 2014 Memorandum for the Secretary from Daniel B. Poneman, Strategy of Reforms to Enhance Security, Independent Assessments, Safety and Health Functions.

provided six categorical tables, which are reproduced at the end of this appendix along with a table of references cited in them:

- Table H-1—Seismic Classification,
- Table H-2—Non-Seismic Natural Phenomena Hazard (NPH) Classification,
- Table H-3—Hazardous Material Confinement Requirements,
- Table H-4—Fire Protection Requirements,
- Table H-5—Nuclear Criticality Safety Requirements,
- Table H-6—Standard Industrial Hazard Requirements, and
- Table H-7—a list of the references cited in Tables H-1 through H-6.

The attached tables reflect specific areas that the site's safety authorization basis staff believes have an impact on final UPF designs and may be interpreted or applied differently to provide sufficient safety margins while allowing less costly designs. The recommendations in the tables are provided for information purposes only, and do not necessarily represent the opinions of the Review Team members who did not have sufficient time to thoroughly vet each suggestion.

Tables H-1 through H-6 contain columns with the following titles:

- Summary of Requirements,
- Integrated Impact to Baseline UPF Design,
- Recommended Directions,
- Safety Risk, and
- Integrated Benefit (resulting from implementing the recommended directions).

The Review Team was able to confirm some examples of the tabulated compounding requirements that significantly adversely affect design and construction costs. Those confirmations contributed to the Review Team's recommendations.

Table H-1. Seismic classification				
Summary of requirements	**Integrated impact to baseline UPF design**	**Recommended direction**	**Safety risk**	**Integrated benefit to UPF alternatives**
The project adopted the design basis for the building structure as seismic design category (SDC)-3 for initial design conservatism. (Ref. 2, 49) The design basis requirement for safety significant and safety class (SC) structures, systems, and components (SSCs), using unmitigated dose consequences is SDC-2 for the Uranium Processing Facility (UPF). (Ref. 3, 4, 7) SSCs for nuclear criticality safety are required to be SDC-2 or SDC-3 (depending on NCS analysis), regardless of functional classification (SS/SC) or dose consequence. (Ref. 1, 5, 7) Safety significant SSCs selected to protect offsite or onsite individuals from chemical hazards must be initially categorized as SDC-3. (Ref. 8). Additionally, there is also a Federal Project Director (FPD) letter that directs the UPF Project to apply the most restrictive requirements and interpretations of guidance for the Project design and to be relaxed only after the approval of CD-1 (Ref. 49)	Initial classification is to be conservative to meet condition of DOE-STD-1189-2008. Based on early immature dose consequence analyses, Building structure established at SDC-3, Limit State D (LS-D). Several SSCs within the UPF are required to be SDC-3 to meet nuclear criticality safety (NCS) or chemical requirements. Since locations of these components are not known early in design, the system interaction requirement of ANSI/ANS-2.26 requires many features of the facility to be designed to high SDC requirements because target interaction cannot be determined. The fire suppression system (FSS) is designed to SDC-3, LS-D because of chemical hazards. The FSS is also credited for protecting NCS relied upon SSCs.	Design structures with post seismic radiological co-located/public risk to SDC-3 to meet overall confinement strategy of hazardous materials and prevent facility collapse for NDC-3 event required by DOE-STD-1020-2012. SS SSCs, SSCs for chemical hazards, and NCS SSCs relied upon to meet safety function post seismic, should be designed to SDC-2. LS-D to be used for conditions where containment for fissile material is required to ensure subcriticality or to protect co-located worker or public. For other internal SSCs, an SDC-1 may be used as the design basis. This may require a limited exemption from DOE-STD-1020-2012 and removal of Central Technical Authority memorandum.	Minimal. Co-located worker and public dose consequence mitigated by robust building structure. Impact of nuclear criticality accident is limited to facility worker and seismic position is supported by DOE Criticality Safety Support Group (Ref. 10). Decreased seismic requirements on internal SSCs will not adversely impact co-located worker or public	Reduces cost associated with SDC-3 internal SSCs and minimizes costs associated with "two over one" phenomena. Advanced design maturity allows for identification of specific SSC "targets" that can be demonstrated to be protected from a seismic event without designing all SSCs to enhanced seismic design criteria.

Seismic system interaction (two-over-one phenomena) must be analyzed and designed for. (Ref. 9) The higher of SDCs from radiological or chemical hazards should be used. (Ref. 6)				

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Table H-2. Nonseismic natural phenomena hazard classification				
Summary of requirements	**Integrated impact to baseline UPF design**	**Recommended direction**	**Safety risk**	**Integrated benefit to UPF alternatives**
The specific guidance on establishing the NDC (or Performance Category) design criteria for non-seismic hazards is not straightforward. DOE-STD-1189-2008 does not provide direct design requirements for non-seismic Natural Phenomena Hazard (NPH) events. DOE Order 420.1C refers to DOE-STD-1020-2012, which refers to ANSI/ANS-2.26 for the categorization process. The methodology of ANSI/ANS-2.26 could require criteria up to NDC-5. Therefore, based on interpretation of the above documents, the project design basis for the main building structure is NDC-3 (PC-3). (Ref. 1, 3, 5, and 8). The NDC-3 categorization is based on chemical hazards. If based on radiological hazards, the category would be NDC-2.	Based on early immature dose and chemical consequence analyses, the facility is designed to PC-3 for chemical hazards that require the facility to design for tornados, high winds, flooding, and excess precipitation events. (Ref. 49)	Limit the safety basis chemical hazards to only include chemical hazards if they are unique to the process and are not governed by national codes or standards. This limits the chemical hazards to be considered for non-seismic NPH events. This design posture requires interpretation from DOE-STD-1020-2012 that SSCs for NCS does not require NDC-3 as the design basis for all non-seismic events.	Minimal. Co-located worker and public dose consequence mitigated by robust building structure.	Reduces cost associated with NDC-3 design, in particular design against tornado missile hazards.

Table H-3. Hazardous material confinement requirements				
Summary of requirements	**Integrated impact to baseline UPF design**	**Recommended direction**	**Safety risk**	**Integrated benefit to UPF alternatives**
Hazard category 1, 2, and 3 nuclear facilities with uncontained radioactive must have the means to confine the uncontained radioactive materials to minimize their potential release in facility effluents during normal operations and during and following accidents, up to and including design basis accidents (DBAs). An active confinement ventilation system is the preferred design approach for nuclear facilities with potential for radiological release. (Ref. 11 – 19) The active confinement ventilation system is functionally classified per the requirements of DOE-STD-1189-2008 and DOE-STD-3009.	The active confinement ventilation system for the Uranium Processing Facility is functionally classified as defense-in-depth based on unmitigated radiological consequences. As defense-in-depth, the system is not required to function post-fire or post-seismic. However, as a significant control in the confinement strategy and in consideration of the beyond design basis event evaluation required by 10 CFR 830, a portion of the system was seismically classified as seismic design category (SDC)-2. This designation carried over to the backup power diesel generators. A fire deluge system was not designed per DOE-STD-1066 because of defense-in-depth classification. (Ref. 33, 34)	Maintain current radiological confinement strategy. The only change would be to design the confinement ventilation system to SDC-1. The cost impact of elevating the confinement ventilation system to SDC-2 is not quantified at this time.	None.	Already designed to minimum requirements with the exception of seismic design.

Table H-4. Fire protection requirements

Summary of requirements	Integrated impact to baseline UPF design	Recommended direction	Safety risk	Integrated benefit to UPF alternatives
Automatic suppression is required throughout the facility for property loss protection and safety function requirements. (Ref. 20-23, 26, 27, 30, 35) Fire barriers are required for multiple fire protection approaches and to protect safety analysis initial conditions. (Ref. 22, 27) Fire detection systems are required for property loss protection and facility worker protection. (Ref. 22, 27) Fire water runoff collection capability required for contamination control and flooding control. (Ref. 28, 31) Structure must survive design basis fire and continue to act as a confinement structure. (Ref. 32) Functional classification of fire protection systems shall meet requirements of DOE-STD-3009 and DOE-STD-1189. (Ref. 24, 25, 29, 35, 36)	Fire suppression system classified as safety significant for chemical hazards and protection of nuclear criticality safety (NCS) structures, systems, and components (SSCs). Fire barriers are classified as safety significant, but designed to safety class standards to protect initial conditions in the safety analysis and to address consequence analysis of seismic fire being greater than 5 rem. Fire detection systems are classified as safety significant to protect workers from chemical hazards and energetic events. Structural steel is covered in fire proofing material or concrete to ensure structure remains operable after design basis fire. Suppression systems, fire barriers, and structure are assigned seismic design category (SDC)-3.	Reassess need to elevate chemical hazards to SS (instead of standard industrial hazard) Reassess functional classification of fire suppression system, fire barriers, and fire detection systems. Reassess seismic design criteria for fire suppression system and fire barriers.	Minimal. Radiological consequence analysis shows that doses are below the threshold for safety significant. Systems still functional to meet safety needs. The seismic design category [SDC-3, Limit State (LS)-D) are established for chemical hazards and to protect leakage from sprinkler water onto NCS SSCs in a post seismic condition. Relaxation of the seismic criteria to SDC-2, LS-B would still meet requirements and preserve the safety function, albeit with possible minor leaks in the suppression system.	Reduces integrated cost to facility by simplifying construction and procurement of fire protection systems. Downgrade of seismic classification reduces seismic design criteria of internal systems by reducing or eliminating “two over one” requirements.

Table H-5. Nuclear criticality safety requirements				
Summary of requirements	**Integrated impact to baseline UPF design**	**Recommended direction**	**Safety risk**	**Integrated benefit to UPF alternatives**
Process with fissile material must be designed to remain subcritical under normal and credible abnormal conditions, including those initiated by design basis events. (Ref. 37 – 39) Where practicable, reliance should be placed on equipment design in which dimensions are limited rather than on administrative controls. (Ref. 40 - 41)	The facility systems are to be designed to ensure subcriticality for all normal and credible abnormal conditions. The control hierarchy is passive engineered over active engineered controls, with administrative control the least preferable. The inclusion of all design basis events elevates requirements of seismic design and fire scenarios to nuclear criticality safety structures, systems, and controls, as noted in other tables.	Maintain requirements. Consider reduction of seismic requirements as noted in associated table.	None. Maintaining the requirements continues to protect the facility worker, co-located worker, and public.	Reduction of seismic requirements reduces consequential cost impacts on the rest of design.

Table H-6. Standard industrial hazard requirements

Summary of requirements	Integrated impact to baseline UPF design	Recommended direction	Safety risk	Integrated benefit to UPF alternatives
Standard Industrial Hazards are hazards that are routinely encountered in general industry and construction, and for which national consensus codes and/or standards exist. *Standard industrial hazards are identified only to the degree they are initiators and contributors to accidents in main processes and activities. (Ref. 42, 43, 46)* Clear distinction between a documented safety analysis (DSA) hazard and a standard industrial hazard must be made in the DSA (Ref. 44). The requirement is made vague by the following requirements: Safety-significant designations of structures, systems, components (SSCs) based on worker safety are limited to those systems, structures, or components whose failure is estimated to result in a prompt worker fatality or serious injuries to workers or significant radiological or chemical exposures to workers (Ref. 45)	The subjective requirements tends to drive many chemical hazards into safety significant controls, even if there is a national consensus standard applicable to the hazard. Therefore, the controls are designed to more stringent requirements (e.g., Ref. 24). In addition to toxic chemical hazards driving stringent requirements, other events such as those identified in DOE-STD-1189 (e.g., energetic events and asphyxiation) drive safety significant controls. Although these other events are in guidance contained in appendices, the guidance is often reflected as requirements. (Ref. 49)	Define standard industrial hazards as those worker hazards that act as initiators or contributors to chemical or radiological accidents, or result from those hazards. Furthermore, only include chemical hazards if they are unique to the process and are not governed by national codes or standards.	Minimal. All facility worker hazards are still addressed and controls are still provided. Applying a strict definition only identifies which program the worker hazard is addressed under: 10 CFR 830 or 10 CFR 851.	This will reduce the additional design, construction, and life cycle cost for energetic events, and some chemical events.

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Table H-6 (continued)

Summary of requirements	Integrated impact to baseline UPF design	Recommended direction	Safety risk	Integrated benefit to UPF alternatives
There are conditions that warrant consideration of safety significant SSCs. These include the following (Ref. 48): • energetic releases of radiological and toxic chemicals • deflagrations or explosions • chemical or thermal burns • asphyxiation from process system leaks • Concurrent releases of different chemicals (Ref. 47)				

<table>
<tr><th colspan="3">Table H-7. References</th></tr>
<tr><th>Ref. No.</th><th>Reference</th><th>Requirement</th></tr>
<tr><td>1</td><td>DOE Order 420.1C, Attachment 2, Chapter III, 3(f)</td><td>Criticality safety evaluations must show that entire processes involving fissionable materials will remain subcritical under normal and credible abnormal conditions, including those initiated by design basis events.</td></tr>
<tr><td>2</td><td>DOE-STD-1189-2008, Section 2.4.2</td><td>The overarching philosophy and logic in this Standard is that a heightened degree of conservatism is demanded in the earlier phases of a project when the design details are not available.</td></tr>
<tr><td>3</td><td>DOE-STD-1189, Table A.1</td><td><table>
<tr><th></th><th colspan="2">Unmitigated Consequence of SSC Failure</th></tr>
<tr><th>Category</th><th>Collocated Worker</th><th>Public</th></tr>
<tr><td>SDC-1</td><td>Dose < 5 rem</td><td>Not Applicable (SDC-1 at a minimum)</td></tr>
<tr><td>SDC-2</td><td>5 rem < dose < 100 rem</td><td>5 rem < dose < 25 rem</td></tr>
<tr><td>SDC-3</td><td>100 rem < dose</td><td>25 rem < dose</td></tr>
</table></td></tr>
<tr><td>4</td><td>DOE-STD-1020-2012 Section 2.2.2.1</td><td>For hazard category 1, 2, and 3 nuclear facilities, the NDCs for safety (i.e., safety class and safety significant) SSCs shall be determined based on analysis of the severity of unmitigated consequences using the categorization methodology given in Appendix A of DOE-STD-1189-2008.</td></tr>
<tr><td>5</td><td>DOE-STD-1020-2012, Section 2.3.7</td><td>Credible design basis NPH events for the purposes of criticality process analysis are those equivalents to NDC-3. The criticality process analysis will identify applicable SSCs relied upon to ensure subcriticality during credible abnormal conditions. NPH Design Category and limit states are assigned depending upon the required safety function. For the purposes of applying ANSI/ANS-2.26-2004 as interpreted by DOE-STD-1189-2008, criticality hazards are treated like any other radiological hazard with the following exception: the SSCs whose safety function establishes single contingency for NPH shall be designed to a NPH Design Category NDC-3 and appropriate limit states (i.e., SSCs whose NPH-initiated failure alone can lead directly to a criticality accident shall be designed to NDC-3 with deformation limits established to prevent the criticality accident). If a process cannot be shown to meet the ANSI/ANS-8.1-1998, Nuclear Criticality Safety I Operations with Fissionable Materials Outside Reactors, recommendation for double contingency for NPH events because of NPH induced SSC failure, DOE O 420.1C requires an explanation in the DOE approved Criticality Safety Program for not implementing a recommendation in the applicable ANSI/ANS-8 Standards.</td></tr>
<tr><td>6</td><td>DOE-STD-1020-2012, Section 2.3.9</td><td>The higher of the NDCs determined from the application of radiation dose criteria and the criteria for chemical dose should be used.</td></tr>
</table>

Table H-7 (continued)		
Ref. No.	**Reference**	**Requirement**
7	Memorandum dated June 14, 2012 from Thomas P. D'Agostino to Daniel Hoag, titled "Central Technical Authority Concurrence with Technical Positions of the Uranium Processing Facility Project"	This memorandum provided the CTA concurrence with the following UPF technical positions: For all existing NNSA projects, the SDC designations in Table A.1 of DOE-STD-1189, *Integration of Safety into the Design Process*, are only required for safety SSCs (Safety Class or Safety Significant). Non-safety SSCs need to only be designed to SDC-1. Nuclear criticality safety design features at UPF will be assigned SDC-2 and appropriate limit state to prevent a criticality accident as a result of damage from the design basis seismic event. Further, where it is identified that failure of a nuclear criticality safety design feature during or following a seismic event has the potential to directly result in a nuclear criticality accident (i.e., there are no other effective controls in a post-seismic condition that ensure sub-criticality), the design feature will be assigned SDC-3 and appropriate limit state. DOE O 420.1 provisions regarding single contingent conditions still apply and must be met.
8	Memorandum dated July 9, 2009 from Thomas P. D'Agostino to the Deputy Administrator for Defense Programs, titled "Guidance and Expectations for DOE-STD-1189-2008, *Integration of Safety into the Design Process*, Natural Phenomena Hazard Design Basis Criteria for Chemical Hazard Safety Structures, Systems, and Components".	This memorandum provides the following chemical hazard criteria for assigning Seismic Design and Performance Categories: Safety significant SSCs selected to protect offsite or onsite (100m) individuals from chemical hazards must be initially categorized as Seismic Design Category (SDC)-3 when seismic hazards are involved, or Performance Category (PC)-3 for other NPH-initiated events. Suggested guidelines for selecting safety significant SSCs to protect offsite and onsite (100m) individuals from chemical hazards may be found in Appendix B of DOE-STD-1189.[See Note 1] Safety significant SSCs selected for chemical hazards to protect facility workers who are required to remain in the facility either for safe shutdown or to perform another safety related purpose must be initially categorized as SDC-3 when seismic hazards are involved, or PC-3 for other NPH-initiated events. Suggested guidelines for selecting safety significant SSCs to protect facility workers from chemical hazards may be found in Appendix C of DOE-STD-1189.[See Note 1] Safety significant SSCs selected to protect other facility workers from chemical hazards must be categorized as SDC-2 when seismic hazards are involved, or PC-2 for other NPH-initiated events. For SSCs that must be designed for seismic and wind, flood and snow loads, such as external building structures, there will be a need to resolve the differences in design requirements identified by the Seismic Design Categorization and the Performance Categorization resulting from consideration of wind, flood and snow loads. This resolution must be done conservatively; i.e., the SSC design must achieve the desired protection for the applicable NPH loads. Similarly, differences in design requirements identified by the Seismic Design Categorization/Performance Categorization resulting from the evaluation of chemical versus radiological hazards must also be resolved conservatively. <u>NOTE 1</u> SDC-2 or PC-2 categorization may be adopted with appropriate justification. Specifically, SDC-2 or PC-2 categorization may be justified if, based on technical and/or cost-benefit considerations, SDC-3 or PC-3 categorization would create an unreasonable burden on the project. This technical justification and/or cost-benefit analysis must be forwarded to the Acquisition Executive for approval, with a copy provided to the Chief of Defense Nuclear Safety.

<table>
<tr><th colspan="3">Table H-7 (continued)</th></tr>
<tr><td>9</td><td>ANSI/ANS-2.26, Section 6.3.2.4</td><td>System interaction considerations shall also include the adverse effects of failure of a lower-category (i.e., SDC or Limit State) SSC (i.e., the source SSC) on the safety function of a higher category SSC (i.e., the target SSC). The target SSC is to withstand the imposed loading.</td></tr>
<tr><td>10</td><td>CSSG Tasking 2010-01, “Balanced Technical Approaches for Addressing Potential Seismically Induced Criticality Accidents in New Facility Design”</td><td>“Criticality accidents are expected to be worker safety issues and not pose significant risks to co-located workers or the public. Thus, based on using the same radiological considerations for other events, Seismic Design Criteria {SDC) 1 with Limit State {LS) B or C is appropriate for most structures and equipment important to criticality accident prevention." … “According to this excerpt, other considerations in addition to radiological consequences may be considered in assigning SDC levels to SSCs related to criticality safety. DOE-STD-1189 recognizes that for worker protection events, safety management programs are the primary means of defense, however there may be events which occur so quickly that safety management program protections would not be effective. For example if failure of a component during a design basis earthquake (DBE) would create the potential for an immediate criticality accident, that component might require a higher SDC. Based on the excerpt from DOE-STD-2010-2002 given above, SDC-2 with LS–B or -C (or –D in certain cases) might be appropriate. According to the citation above, assignment of SDC-2, LS-B or –C might be appropriate for SSCs important to criticality safety. However, the CSSG acknowledges the fact that both DOE-STD-2010- 2002 and DOE G 420.1-2 consider criticality accidents as a special case for assignment of SDC levels. It is further noted that while both documents indicate that SDC-3 (previously Performance Category 3) should be assigned (no LS values cited in the documents) to SSCs relied on for criticality safety there is not consistency between the standards on what cases would require SDC-3. While the CSSG position is that the dose consequence from a criticality safety accident does not in general warrant assignment of SDC-3 levels to SSCs, the CSSG acknowledges the fact that the application of other than consequence criteria may result in assignment of SDC-3. The CSSG recommends that DOE evaluate the basis and justification for treating criticality differently from other radiological hazards.”</td></tr>
<tr><td>11</td><td>Memorandum dated May 8, 2008 from Glenn S. Podonsky to Thomas P. D’Agostino, titled “Issuance of Department of Energy Standard 1189”</td><td>This memorandum provides the radiological categorization criteria for use with respect to wind and flooding NPH events. The Performance Categorization radiological criteria are consistent with the criteria described in DOE-STD-1189, Appendix A, for seismic hazards.

The PC radiological criteria discussed above is summarized in the following table –

<table>
<tr><th></th><th colspan="2">Unmitigated Consequence of SSC Failure</th></tr>
<tr><th>Category</th><th>Collocated Worker</th><th>Public</th></tr>
<tr><td>PC-1</td><td>Dose < 5 rem</td><td>Not Applicable</td></tr>
<tr><td>PC-2</td><td>5 rem < dose < 100 rem</td><td>5 rem < dose < 25 rem</td></tr>
<tr><td>PC-3</td><td>100 rem < dose</td><td>25 rem < dose</td></tr>
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</td></tr>
</table>

Table H-7 (continued)		
12	DOE Order 420.1c Attachment 2, Chapter I, (3)(b)(3)	Hazard category 1, 2, and 3 nuclear facilities with uncontained radioactive materials (as opposed to materials determined by safety analyses to be adequately contained within qualified drums, grout, or vitrified materials) must have the means to confine the uncontained radioactive materials to minimize their potential release in facility effluents during normal operations and during and following accidents, up to and including design basis accidents (DBAs). Confinement design must include the following: (c) An active confinement ventilation system as the preferred design approach for nuclear facilities with potential for radiological release.3 Alternate confinement approaches may be acceptable if a technical evaluation demonstrates that the alternate confinement approach results in very high assurance of the confinement of radioactive materials. The guidance for confinement ventilation systems and evaluation of the alternatives, is provided in DOE Guide (G) 420.1-1A, *Nonreactor Nuclear Safety Design Guide for Use with DOE O 420.1C, Facility Safety*.
13	DOE Order 420.1c Attachment 2, Chapter I, (3)(b)(4)	Protect against chemical hazards and toxicological hazards consistent with DOE-STD-1189-2008 and direction from the responsible program office. Appendix B of DOE-STD-1189-2008 provides additional guidance for protection against chemical hazards and toxicological hazards.
14	DOE Order 420.1c Attachment 2, Chapter I, (3)(h)	Specific Fire Protection Program Criteria. DOE-STD-1066-2012 provides acceptable methods for implementing the requirements in DOE O 420.1C; other methods may be acceptable. Any alternate approach must provide an equivalent level of safety.
15	DOE Order 420.1c Attachment 3,(a)(2)	Safe Failure Modes. The facility design must provide reliable safe conditions and sufficient confinement of hazardous material during and after all design basis accidents. At both the facility- and SSC-level, the design must ensure that most probable modes of failure (e.g., failure to open versus failure to close) will increase the likelihood of a safe condition.
16	DOE Order 420.1c Attachment 3,(a)(5)	Support System and Interface Design. (a) Support SSCs must be designed as safety-class or safety-significant SSCs if their failures prevent safety-SSCs or specific administrative controls from performing their safety functions. (b) Interfaces, such as pressure retention boundaries, electrical supply, instrumentation, cooling water, and other support systems may exist between safety-SSCs and non-safety-SSCs. These interfaces must be evaluated to identify SSC failures that would prevent safety-SSCs from performing their intended safety function. IEEE Std 384-2008, *IEEE Standard Criteria for Independence of Class IE Equipment and Circuits*, or other applicable standards must be used for physical and electrical separation methods, including the use of separation distance, barriers, electrical isolation devices, or any combination thereof. This includes a design to ensure that both direct and indirect impacts of design basis accidents (e.g., fire, seismic) will not cause failure of safety functions.
17	DOE G 420.1-1, Section 4.4.2	All airborne effluents from areas in which hazardous or radioactive materials are managed other than in closed containers should be exhausted through a ventilation system designed to remove particulate material, vapors, and gases, as necessary, to comply with applicable release requirements and to reduce releases of radioactive materials to levels ALARA.

<table>
<tr><th colspan="3">Table H-7 (continued)</th></tr>
<tr><td>18</td><td>DOE G 420.1-1, Section 5.2.2.2</td><td>The usual safety function of process equipment is to provide primary confinement and prevent or mitigate radioactive and/or hazardous material releases to the environment. Process equipment that would be required to provide primary confinement includes the following: piping, tanks, pressure vessels, pumps, valves, and gloveboxes. Safety-class and safety-significant process equipment providing passive confinement (piping, tanks, holding vessels, etc.) must be designed to suitably conservative criteria; redundancy in their design is not required.</td></tr>
<tr><td>19</td><td>DOE G 420.1-1A, Appendix A, Table A-1</td><td>
<table>
<tr><th>Design / Performance (selected criteria)</th><th>Safety Significant</th><th>Defense-in-Depth</th></tr>
<tr><td>Exhaust system should withstand anticipated normal, abnormal and accident system conditions and maintain confinement integrity</td><td>Applies</td><td>Applies</td></tr>
<tr><td>Reliability of control system to maintain confinement function under normal, abnormal and accident conditions</td><td>Applies</td><td>Applies</td></tr>
<tr><td>CVSs should withstand credible fire events and be available to operate and maintain confinement</td><td>Applies</td><td>Does Not Apply</td></tr>
<tr><td>CVSs should not propagate spread of fire</td><td>Applies</td><td>Does Not Apply</td></tr>
<tr><td>CVSs should safely withstand earthquakes</td><td>Applies</td><td>Does Not Apply</td></tr>
<tr><td>CVS should safely withstand tornado depressurization</td><td>Applies</td><td>Does Not Apply</td></tr>
<tr><td>Backup electrical power will be provided to all critical instruments and equipment required to operate and monitor the CVS</td><td>Applies</td><td>Does Not Apply</td></tr>
</table>
</td></tr>
<tr><td>20</td><td>DOE Order 420.1c Attachment 2, Chapter II, (3)(a)(2)</td><td>Codes and Standards. Fire protection and emergency response programs must meet, or exceed, the applicable building code and National Fire Protection Association (NFPA) codes and standards.</td></tr>
</table>

Table H-7 (continued)		
21	DOE Order 420.1c Attachment 2, Chapter II, (3)(c)(2)	Protection Thresholds. (a) New facilities (non-re-locatable) exceeding 5,000 sq ft of floor area must be of Type I or Type II construction, as defined in the applicable building codes. (b) Automatic fire suppression systems must be provided throughout new facilities exceeding 5,000 sq ft of floor area or where a maximum possible fire loss exceeds $5 million, unless the NFPA code(s) allow for specific relief within the facility. (c) Automatic fire suppression systems must be provided throughout facilities in which any of the following conditions exist: 1 where required by safety basis document (for example, to prevent loss of safety functions or provide defense-in-depth); 2 significant life safety hazards; 3 where fire may cause unacceptable mission or program interruption if automatic fire suppression systems are not provided; 4 where a modification to a facility would cause the maximum possible fire loss (MPFL) to exceed $5 million; or, 5 where a modification causes a facility to exceed 5,000 sq ft of floor area. (d) For property protection, multiple fire protection approaches, such as a fire suppression system and a fire detection and alarm system, must be provided in areas where the MPFL exceeds $150 million (refer to DOE-STD-1066-2012). (e) For property protection, fire areas must be established such that the MPFL for each fire area does not exceed $350 million. Fire area walls or other separation approaches may be used to meet this requirement.
22	DOE Order 420.1c Attachment 2, Chapter II, (3)(c)(3)	(a) Fire Suppression. The inadvertent operation or failure of fire suppression systems must not result in the loss of function of safety-class or safety-significant systems. (Note: This requirement addresses proper design of the fire suppression system to ensure it does not impact safety systems and is not intended to drive need for redundancy in safety-significant system design.) (b) Fire Barriers. Complete fire-rated construction and barriers, commensurate with the applicable codes and/or safety basis requirements, must be provided to isolate hazardous areas and minimize fire spread and loss potential consistent with limits as established in this chapter. Fire barrier locations and construction must be documented. (c) Fire Detection. Automatic fire detection must be provided to the extent required by applicable industry codes and standards.
23	DOE Order 420.1c Attachment 2, Chapter II, (3)(g)(3)	(d) Where no alternative exists to criticality safety restrictions on the use of water for fire suppression, the need for such restrictions must be fully documented with written technical justification.
24	DOE Order 420.1c Attachment 3,(a)(2)	System Reliability. (a) The single failure criterion, requirements, and design analysis identified in Institute of Electrical and Electronics Engineers (IEEE) standard (Std) 379-2000, *IEEE Standard Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems*, must be applied to safety-class SSCs during the design process as the primary method of achieving reliability. American National Standards Institute (ANSI)/American Nuclear Society (ANS) 58.9, *Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems*, may be used in defining the scope of active safety-class mechanical SSCs. (b) Safety-significant SSCs must be designed to reliably perform all their safety functions. This can be achieved through a number of means, including use of redundant systems/components, increased testing frequency, high reliability components, and diagnostic coverage (e.g., on-line testing, monitoring of component and system performance, and monitoring of various failure modes). DOE STD-1195-2011, *Design of Safety Significant Safety Instrumented Systems Used at DOE Nonreactor Nuclear Facilities*, provides an acceptable method for achieving high reliability of safety-significant safety instrumented systems.

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Table H-7 (continued)

25	DOE Order 420.1c Attachment 3,(b)(7)	Fire Protection Systems. DOE-STD-1066-2012, *Fire Protection*, provides acceptable methods for the design of fire protection systems, including safety-class and safety-significant fire barriers, water supplies, and wet pipe sprinkler systems (see Appendix A of DOE-STD-1066-2012). Fire protection system designs are also required to address the applicable design requirements for similar safety systems provided in this attachment (e.g., the fire detection and alarm system would be designed consistent with safety-related instrumentation and control systems).
26	DOE-STD-1066-2012, Section 2.2.2.3	Hazard category 1, 2, and 3 nuclear facilities should be classified as Group H-4 (high hazard) occupancies unless modified by the AHJ. If sufficient levels of other hazardous materials exist, an alternate classification of Group H occupancy should be used.
27	DOE-STD-1066-2012, Section 4.2.3	DOE O 420.1C requires that multiple fire protection approaches be provided for property protection in areas where the maximum possible fire loss (MPFL) exceeds $150 million. When multiple fire protection approaches are required for other than nuclear safety (e.g. property protection, mission continuity, etc.), any two of the following are considered satisfactory: Automatic suppression systems, such as fire sprinklers, foam, gaseous, explosion suppression, or other specialized extinguishing systems plus appropriate alarms. An adequate extinguishing agent supply, storage, and distribution system is an essential element. Automatic fire detection, occupant warning, manual fire alarm, and fire alarm reporting systems (considered together) combined with a sufficiently-staffed, properly-equipped, and adequately-trained fire department or brigade that is able and committed to respond in a timely and effective manner. Fire barriers of sufficient ratings. For outdoor locations, sufficiently rated fire barriers, or a combination of physical separation and barriers.
28	DOE-STD-1066-2012, Section 4.2.5.4	Drainage. When high-value property, safety structures systems and components, or critical process equipment is subject to flooding from the discharge of automatic sprinkler systems and/or use of manual hose streams, protection against water damage shall be provided by one or more of the following methods: Floor drains; Pits, sumps and sump pumps; Equipment pedestals; or, Other acceptable alternatives.
29	DOE-STD-1066-2012, Section 4.2.7.1	Water Supply. DOE O 420.1C requires that a reliable and adequate water supply and distribution system be provided for fire suppression, as documented through appropriate analysis. Redundant water supplies (storage and pumping systems) are necessary when either a fire protection water supply system is classified as SC (see Appendix A of this Standard), or when the maximum possible fire loss exceeds $350 million in any site facility. 4.2.7.1.1 Adequacy. The water supply should be designed to meet the following combined demands for a period of not less than two hours: 1) largest single fire suppression system; 2) 500 gallons per minute (gpm) for fire hose streams; and 3) uninterruptable domestic and process demands. 4.2.7.1.2 Reliability. The water supply and distribution system should be designed to prevent a single failure from causing the system to fail to meet its demand. Design features should include looped and gridded distribution piping with sectional valves and redundant supplies (pumps and tanks or elevated water sources).

Table H-7 (continued)		
30	DOE-STD-1066-2012, Section 4.2.7.8	Special Suppression Systems. When automatic sprinkler or water spray protection systems cannot be safely employed or need to be supplemented, the decision to install another type of fire suppression system should be based on engineering analysis performed by, or under the direction of, a FPE. The analysis should consider, in addition to initial design and installation cost, the long-term cost of inspection, testing, and maintenance (ITM) of the system over its useful life, especially where access for the performance of increased ITM activities may be difficult due to security or radiological concerns.
31	DOE-STD-1066-2012, Section 4.4.1.3	If the facility contains surface contamination, or if the fire could result in the release of radioactive material, the fire suppression water shall be contained, monitored, and treated as necessary. The containment system shall be capable of collecting fire suppression water for a minimum of 30 minutes.
32	DOE-STD-1066-2012, Section 4.4.1.7	When required by DOE O 420.1C, the confinement structure surrounding critical areas and their supporting members are to remain standing and continue to act as a confinement structure during anticipated fire conditions including failure of any fire suppression system. Fire resistance of this shell should be attained by an integral part of the structure (concrete slabs, walls, beams, and columns) and not by composite assembly (membrane fireproofing).[31] Additionally, the structure's fire resistance rating shall be designed for the maximum fire exposure and duration anticipated, but not less than two hours.
33	DOE-STD-1066-2012, Section 4.4.3	Nuclear Confinement Ventilation System Fire Protection Fire protection in or around nuclear confinement ventilation systems in facilities shall be designed to accomplish the following objectives: 1) prevent fires from affecting the operation of the ventilation system; 2) protect the filtration function; and, 3) prevent the release of material that has accumulated on filters.
34	DOE-STD-1066-2012, Section 4.4.3.13	Suppression of Fires in Final (HEPA Filters (when HEPA filters serve as the final means of effluent treatment). The provisions of Sections 4.4.3.1 and 4.4.3.11, of this Standard, are intended to prevent HEPA filter media from being ignited. A capability to suppress a fire shall be provided in final HEPA filter plenums, with the primary objective to prevent an unacceptable release of radioactive materials on the filters. This suppression capability may be provided by a manual deluge system or bubble-tight isolation dampers, depending on analysis in the FHA. If the FHA determines that isolation of the assembly described in 4.4.3.14 is insufficient to prevent release (e.g., the filter fire is deemed severe enough to breach the filter assembly enclosure prior to suffocation from isolating any inlet air), sprinkler or water spray protection should be provided as described in the following sections.
35	DOE-STD-1066-2012, Section A.1.1	System Function and Critical Characteristics The SC and SS function of the fire protection system is defined in the Documented Safety Analysis (DSA) or other safety basis documentation of the facility (typically in Chapter 4 of the DSA). DOE-STD-3009-94, *Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Documented Safety Analyses,* specifies that Chapter 4 of the DSA documents "the reason for designating the structures, systems, and components (SSC) as a SC SSC, followed by specific identification of its preventive or mitigative safety function(s) as determined in the hazard and accident analysis. Safety functions are top-level statements that express the objective of the SSC in a given accident scenario."
36	DOE-STD-1066-2012, Section A.2.1.1	Additionally, documentation shall include conditions under which the sprinkler system is to remain operable to prevent or mitigate analyzed events (e.g., seismic and loss of power events). The NFPA and DOE-STD-1066-2012-related design requirements should also be identified in the system design description.

Table H-7 (continued)		
37	DOE Order 420.1C, Attachment 2, Chapter III, Section 3(f)	Criticality safety evaluations must show that entire processes involving fissionable materials will remain subcritical under normal and credible abnormal conditions, including those initiated by design basis events.
38	DOE Order 420.1C, Attachment 2, Chapter III, Section 3(b)	The CSP satisfy the requirements of the ANSI/ANS-8 consensus nuclear criticality safety standards
39	ANSI/ANS-8.1, Section 4.1.2	Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions.
40	ANSI/ANS-8.1, Section 4.2.3	Where practicable, reliance should be placed on equipment design in which dimensions are limited rather than on administrative controls.
41	DOE G 420.1-1, Section 2.1.1	In prioritization of items for a facility safety strategy: - Minimization of hazardous materials (material at risk) is the first priority. - Safety SSCs are preferred over Administrative Controls. - Passive SSCs are preferred over active SSCs. - Preventative controls are preferred over mitigative controls. - Facility safety SSCs are preferred over personal protective equipment. - Controls closest to the hazard may provide protection to both workers and the public. - Controls that are effective for multiple hazards can be resource effective.
42	DOE-STD-3009, Definitions	**Hazard.** A source of danger (i.e., material, energy source, or operation) with the potential to cause illness, injury, or death to personnel or damage to an operation or to the environment (without regard for the likelihood or credibility of accident scenarios or consequence mitigation). [10 CFR 830] DSAs specifically examine those hazards inherent in processes and related operations that can result in uncontrolled release of hazardous material (i.e., chemical or radiological) or process-unique energy sources (e.g., high pressure autoclave). Standard industrial hazards do not require DSA coverage. Standard industrial hazards such as burns from hot objects, electrocution, falling objects, etc., are of concern only to the degree that they can be a contributor to a significant uncontrolled release of hazardous material (e.g., 115-volt wiring as initiator of a fire) or major energy sources such as explosive energy. **Standard industrial hazards.** Hazards that are routinely encountered in general industry and construction, and for which national consensus codes and/or standards (e.g., OSHA, transportation safety) exist to guide safe design and operation without the need for special analysis to design safe design and/or operational parameters.

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Table H-7 (continued)		
43	DOE-STD-3009, Section 3.3.1.1	As noted in this Standard's definition of "hazard," standard industrial hazards are identified only to the degree they are initiators and contributors to accidents in main processes and activities. For example, worker electrocution from electrical wiring faults is not a DSA issue. However, the existence of 440 volt AC cabling in a glovebox would be identified as a potential accident initiator for a scenario (i.e., fire) involving hazardous materials. The distinction cited in the previous examples makes careful identification of hazards covered in the DSA essential so that potential worker hazards are not overlooked. As part of the identification process, the basis that was used in the hazard screening to remove standard industrial hazards or insignificant hazards from further consideration needs to be presented as well. For these cases, the DSA hazard analysis process interfaces with other programs such as specific topics of OSHA compliance or general industrial safety. These interfaces must be identified
44	DOE-STD-3009, Section 3.3.2.3	Table 3-1 also provides an example of how worker safety issues are integrated into this presentation. However, significant worker safety evaluations unrelated to the hazard scope defined for a DSA (i.e., standard industrial hazards) will be occurring outside the DSA. This reinforces the importance of the emphasis in Section 3.3.1.1, "Hazard Identification," of identifying the dividing line between process/activity hazards covered in the DSA and those covered by direct OSHA regulatory compliance. Specifying the location of this dividing line is essential to developing an integrated safety posture where the functions of DSA hazard analysis vis-à-vis health and safety plans, job task analyses, etc., is understood.
45	DOE-STD-3009, Section 3.3.2.3.3	As a general rule of thumb, safety-significant SSC designations based on worker safety are limited to those systems, structures, or components whose failure is estimated to result in a prompt worker fatality or serious injuries to workers or significant radiological or chemical exposures to workers (see definition of safety-significant SSCs for further clarification). Inadvertent worker exposure to materials from breached nuclear storage packages during inspections or handling may fit this description.
46	DOE-STD-1189-2008, Appendix B, Section B-1	Chemicals that may be excluded from further analysis for functional classification and the identification of attendant design criteria include the following. Chemicals that can be defined as a Standard Industrial Hazard for which national consensus codes and standards provide for safe design and operation. The consensus code or standard needs to be identified and must be applicable to the use of the chemical in the facility that is to be screened from further evaluation.
47	DOE-STD-1189-2008, Appendix B, Section B-4	For chemical mixtures and concurrent releases of different substances, consequences should be assessed using the Mixture Methodology "Hazard Index" approach recommended by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) Chemical Mixtures Working Group (Craig, et. al., 1999). A brief explanation of this approach and the published journal article are available on the SCAPA website, http://www.orau.gov/emi/scapa/index.htm, under Health Code Numbers (HCN). An EXCEL workbook that automates the implementation of the approach is also available on the SCAPA website. Concurrent releases should be analyzed if a plausible scenario exists by which quantities of different substances could be released from the same location at the same time.

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Table H-7 (continued)		
48	DOE-STD-1189-2008, Appendix C	For each hazardous condition evaluated for the public and collocated worker in the hazards analysis, a qualitative evaluation of unmitigated consequence to the FW and identification of candidate preventive and mitigative controls must be included. While safety management programs (SMP) may include most FW hazard controls, there are conditions that warrant consideration of safety significant structures, systems, and components (SSC). These include the following: energetic releases of high concentrations of radiological or toxic chemical materials where the FW would normally be immediately present and may be unable to take self- protective actions; deflagrations or explosions within process equipment or confinement and containment structures or vessels where serious injury or death to a FW may result from the fragmentation of the process equipment failing or the confinement (or containment) with the FW close by; chemical or thermal burns to a FW that could reasonably cover a significant portion of the FW body where self-protective actions are not reasonably available due to the speed of the event or where there may be no reasonable warning to the FW of the hazardous condition; and leaks from process systems where asphyxiation of a FW normally present may result. Safety significant SSCs are also considered for cases involving significant exposure of the FW to radiological or other hazardous materials. This involves qualitatively evaluating unmitigated consequences in terms of radiation dose, chemical exposure, or physical injury at specified receptor locations.
49	Letter dated September 18, 2007, from Harry Peters (FPD) to John Howanitz (UPF)	1. The UPF structure will be designed and constructed as seismic design category (SDC)-3 and performance category (PC)-3. The SDC category is for seismic performance and the PC category is for all other applicable natural phenomena hazards. 2. All SSC that are credited in the safety basis documents to prevent a nuclear criticality accident will be designed and constructed as SDC-3/PC-3. 3. All SSCs that are credited in the safety basis documents as safety class or safety significant for protection of the public will be designed and constructed as SDC-3/PC-3. 4. All SSCs that are credited for facility worker protection only (except nuclear criticality accidents), will be designed and constructed as SDC-2/PC-2. SDC-3/PC-3 designation for these SSCs may be appropriate for natural phenomena events with the potential for a prompt worker fatality, immediately life-threatening injuries and/or permanently disabling injuries. All SSCs preventing or mitigating the release of hazardous materials exceeding ERPG-3 (emergency response planning guideline) at the emergency response boundary will be designed and constructed as SDC-3/PC-3.